ASSESSMENT OF VIRDEN SEWAGE TREATMENT FACILITY DISCHARGES TO GOPHER CREEK

A. E. Beck,

Water Standards and Studies Section,

Environmental Management Services Branch,

Environmental Management Division.

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SUMMARY

Clean Environment Commission Order #760 Clause 1(g), which prescribed discharge from a proposed deep shaft sewage treatment facility to the Assiniboine River via an enclosed pipe, was appealed by Council of the Town of Virden. Clause 1(g) was subsequently stayed by the Minister of Mines, Resources and Environmental Management until the effect of the effluent upon the receiving stream (Gopher Creek) could be assessed.

A background data base was established by collecting physicochemical data for one year prior to operation of the new treatment facility. Sampling stations were located on Gopher Creek at sites upstream and downstream of the outfall as well as in the effluent outfall itself. Following achievment of full operational status by the deep shaft sewage treatment facility, the background data base was complemented by collection of physicochemical data for another year. The water quality of Gopher Creek prior to operation of the new treatment facility was compared to conditions present in Gopher Creek after full operational status had been achieved. Reference to appropriate water quality criteria provided an assessment of water quality.

The study determined that significant water quality improvements attributable to operation of the new facility occurred in parameters such as non filterable residues, dissolved oxygen, biochemical oxygen demand, total organic carbon, dissolved nitrate-nitrite nitrogen, total coliforms and fecal coliforms. Other parameters such as conductivity, turbidity, pH, total and filterable residues, total inorganic carbon, total kjeldhal nitrogen, ammonia, total phosphorus, sodium, chloride and sulphate were not detectably influenced by operation of the new facility. Notwithstanding the significant water quality improvements noted, inadequate dissolved oxygen levels and excessive un-ionized ammonia concentrations continued to inhibit the maintenance and propagation of sensitive cool water aquatic organisms downstream of the new treatment facility outfall. Excessive fecal coliform levels continued to render downstream reaches of Gopher Creek near the outfall unsuitable for monogastric wildlife usage, direct monogastric livestock watering and primary recreational activities. Lower reaches of Gopher Creek near the confluence with the Assiniboine River, however, were suitable for wildlife usage and direct livestock watering. This lower reach was of marginal quality with respect to primary recreational activities.

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1. INTRODUCTION

Clean Environment Commission Hearing #H-15-77 was held on October 17, 1977 to consider an application by the Town of Virden for prescribing limits on contaminant discharges from the operation of a proposed deep shaft sewage treatment facility. Subsequent to the Hearing, the Clean Environment Commission issued Order #760 on December 5, 1977 (Appendix 3d). Order #760 Clause 1(g), which prescribed discharge to the Assinboine River via an enclosed pipe, was appealed by Council of the Town of Virden on December 13, 1977. The Honourable A. Brian Ransom, Minister of Mines, Resources and Environmental Management, announced on August 18, 1978 his decision to stay Clause 1(g) until the effect of the effluent on Gopher Creek could be assessed. Water Pollution Control Section (then) was assigned this task of assessment. Responsibility for the assessment was later transferred to Water Standards and Studies Section following an internal reorganization.

The purpose of the study was to assess the impact of the deep shaft sewage treatment facility effluent discharges upon the receiving waters of Gopher Creek. Specific objectives to be achieved were:

1. To determine the quality of Gopher Creek over a period of one year, prior to operation of the deep shaft sewage treatment facility;
2. To determine the quality of Gopher Creek over a period of one year after the deep shaft sewage treatment facility had reached full operational status;
3. To assess the impact of deep shaft sewage treatment facility effluent discharges upon Gopher Creek.

2. BACKGROUND*

Virden is a community of 2936 people (1976 census) located approximately 270 kilometres west of Winnipeg. Prior to 1980, the town's sewage had been treated by an Imhoff Tank system. Effluents from the Imhoff Tank had been discharged to Gopher Creek on a continuous basis. Downstream agricultural producers viewed the effluent discharges as the source of odour problems, a public health risk, a detriment to livestock and an unacceptable environmental degradation.

A province-wide thrust to upgrade municipal sewage systems effected the November 15, 1971 Clean Environment Commission issuance of an Interim License (Appendix 3a) for operation of the Town of Virden's sewage treatment facility. Conditions applied to the license required submission of a proposal and commencement of construction of an acceptable sewage treatment facility. Inability to meet the conditions of the Interim License within the prescribed time frame led the Town of Virden to apply to the Clean Environment Commission for continued discharge of effluent to Gopher Creek from the existing Imhoff Tank system. Clean Environment Commission Hearing #H-3-75 considered this application on March 3, 1975. Subsequently, Clean Environment Commission Order #458 (Appendix 3b) was issued on July 3, 1975 and appealed by the Town of Virden on July 30, 1975. The appeal was judged to be a request for variation of the order so as to allow additional time for consideration and installation of an

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*Summarized from Clean Environment Commission file #b-25.1

upgraded sewage treatment facility. The variation hearing was held April 5, 1976 and Clean Environment Commission Order #458VC (Appendix 3c) was issued on April 9, 1976. Order #458VC required, in part, that the proposed new sewage treatment facility specifications and applicable engineering reports be filed with Environmental Management Division by October 31, 1976. The Town of Virden's subsequent application was considered October 17, 1977 at Clean Environment Commission Hearing #H-15-77. Clean Environment Commission Order #760 was issued on December 5, 1977. Order #760 Clause 1(g), which prescribed discharge to the Assiniboine River via an enclosed pipe, was appealed by the Town of Virden on December 13, 1977. A stay of Clause 1(g) was announced by the Minister of Mines, Resources and Environmental Management on August 18, 1978. Disposition of the appeal concerning Clause 1(g) awaits assessment of the impact of the Deep Shaft Sewage Treatment facility's discharges to Gopher Creek.

Subsequent to consultation with the firm of Reid, Crowther and Partners, Limited, Council of the Town of Virden approved construction and installation of the Canadian Industries Limited Deep Shaft Effluent System. The system is an activated sludge process wherein wastewater is mixed with micro-organisms and circulated through a cased shaft. Compressed air injected into the shaft provides oxygen for biochemical oxidation and the driving force for circulation within the shaft. Proposed design specifications for the Virden plant included a shaft of 152.4 m depth and 0.76 m width capable of treating 94.7 m^3 of municipal wastewater per hour (Reid, Crowther and Partners Limited, 1977).

The contract for construction of the sewage treatment plant was let in March, 1979 with a stipulated contract completion date of December 31, 1979. Sewerage from the Town of Virden was diverted into the new Deep Shaft Sewage Treatment Facility on January 31, 1980 with start-up occurring April 30, 1980. Initial operational difficulties delayed turnover of the facility to the Town of Virden until April, 1982.

3. DESCRIPTION OF GOPHER CREEK

Gopher Creek (Figure 1) drains an area (effective drainage area) of approximately 290 square kilometres (Inland Waters Directorate, 1980). Much of the drainage basin is gently undulating agricultural land. Shallow sloughs, generally somewhat alkaline in nature, are abundant.

Upstream of Virden, Gopher Creek is an intermittent stream which normally does not flow during the winter months. The primary source of flow is runoff from spring meltwater and the occasional heavy summer rain. Since 1959, approximately 80% of the total annual stream discharge has occurred during the months of April and May (Ibid). Mean annual total discharges for the period of record (1959 - 1982) have averaged $5.86 \times 10^6 m^3$ per year (Inland Waters Directorate, 1980; 1981; 1982; 1983).

Downstream of Virden, Gopher Creek is a permanent stream. Apart from runoff, major sources of recharge include Virden sewage treatment facility effluents, groundwater seepage and springs. The relative contributions from each source of recharge and mean annual rates of discharge to the Assiniboine River have not been determined.

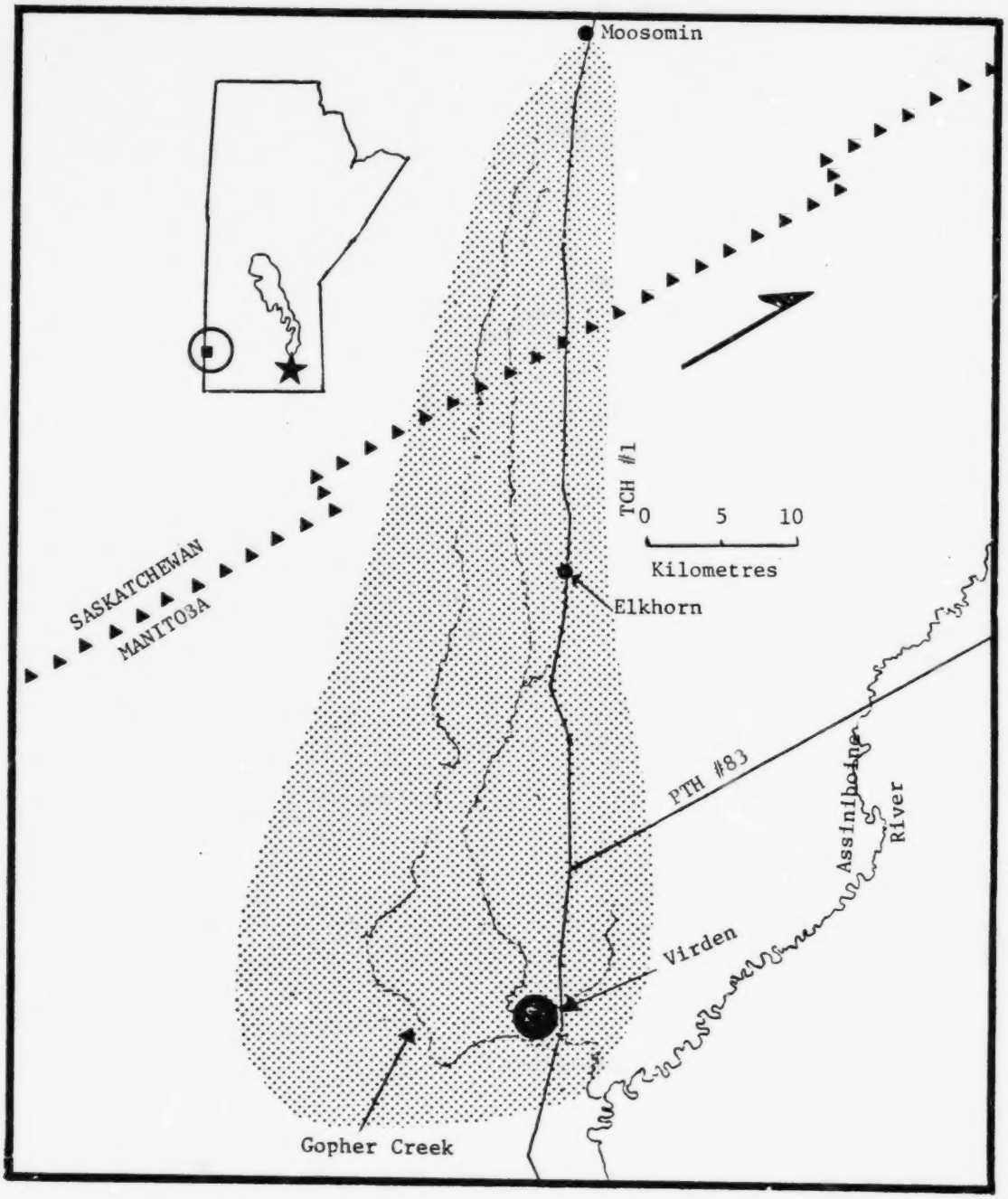

FIGURE 1: Drainage Basin of Gopher Creek

4. STUDY DESIGN AND METHODS

Ideally, impact assessments are conducted by comparing characteristics of the natural state to those of the altered state. Applied to the Virden situation, conditions extant in Gopher Creek after a period of deep shaft system effluent discharges should have been compared to natural conditions extant prior to discharges from any sewage treatment facility. Unfortunately, a background data base derived from Gopher Creek prior to Imhoff Tank discharges was not established*. Thus direct comparisons could only be made between conditions affected by Imhoff Tank discharges and conditions affected by deep shaft system discharges. Impacts upon a natural state could be assessed only indirectly by comparing conditions upstream and downstream of the effluent outfall, or by comparing Gopher Creek conditions to those of a similar sized stream draining a similar watershed. Alternatively, surface water quality objectives could be used to determine the degree of impact.

4.1 STUDY DESIGN

Three sampling stations (Figure 2) were initially established on Gopher Creek for the purpose of direct comparison. Station #1, located at the PR #257 bridge approximately 2.0 kilometres upstream of the sewage treatment facility outfall, provided a control. It was somewhat imperfect as a control because waters usually stagnated during late summer and frequently froze to the bottom during winter. Station #2 was located at the effluent outfall of the sewage

* (The "honey bucket" system was replaced by Imhoff Tank treatment during the early 1950's (E. Wilson, pers. comm.)

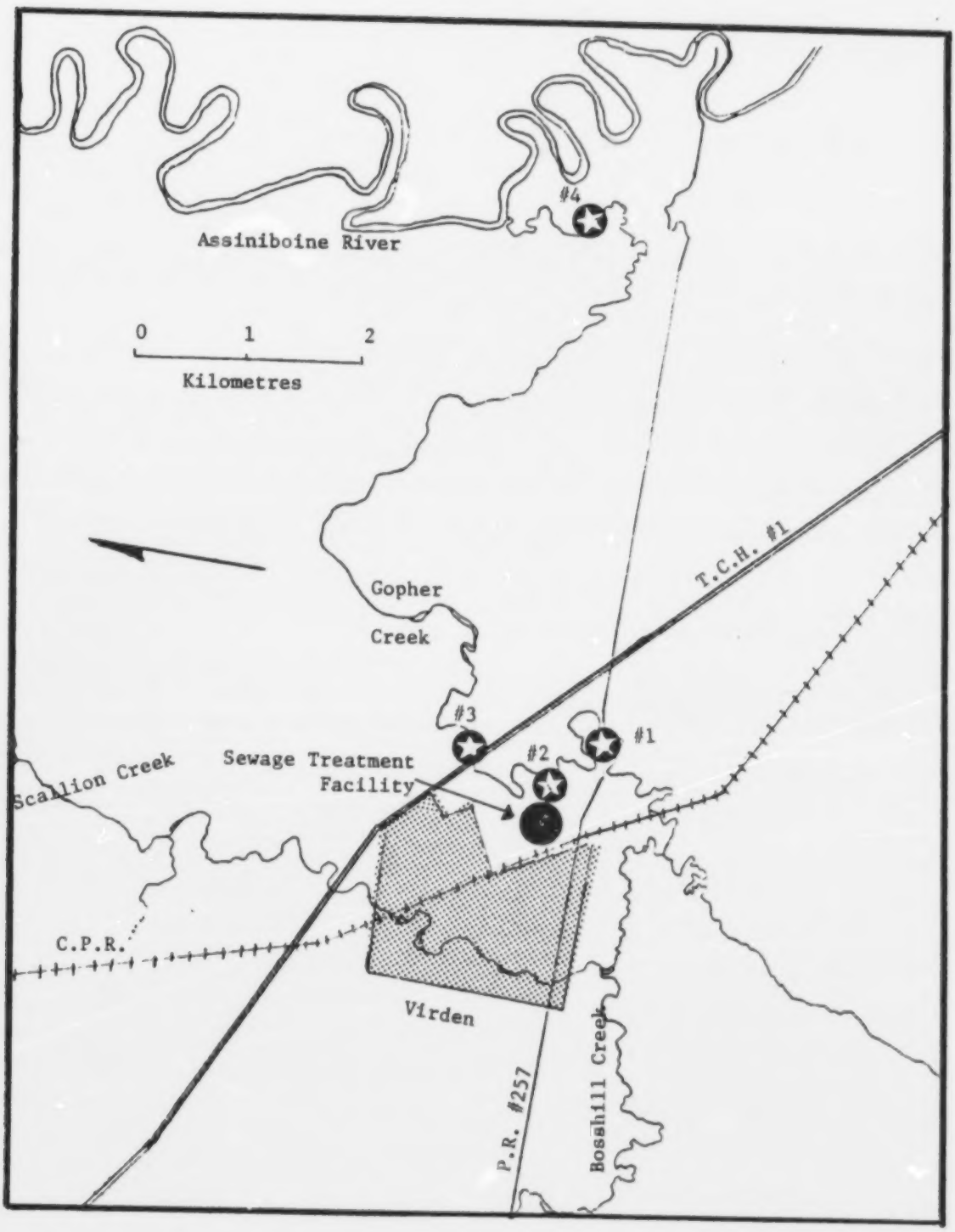

FIGURE 2: Sampling Stations on Gopher Creek

treatment facility. Samples from this site consisted of undiluted effluent. Station #3, located at the Trans-Canada Highway approximately 0.6 kilometres downstream of the effluent outfall, represented fully mixed waters at the upper end of the recovery zone. Although not observed during the present study, waters at station #3, under a natural flow regime, would likely stagnate during late summer and would also probably freeze to the bottom during winter.

Upon assuming responsibility for the assessment, Water Standards and Studies Section added a fourth sampling site. Station #4 (Figure 2) was located on Gopher Creek but within the Assiniboine River floodplain approximately 5.4 kilometres downstream of the sewage treatment facility outfall. This was considered to be at the lower limits of the recovery zone. Station #4 and the immediate environs were thought to be the only portion of Gopher Creek capable of sustaining advanced aquatic organisms such as fish year round under a natural flow regime. Thus, assessment of impact was focussed primarily on station #4 water quality.

Gainsborough Creek, Stoney Creek and Pipestone Creek could each be considered appropriate for the purpose of indirect comparison to Gopher Creek. Characteristics of drainage basins and flow regimes are remarkably similar. However, the intermittent nature of each of these streams prevented the collection and analysis of water samples on a monthly basis and precludes their utility for an indirect comparison to Gopher Creek. Thus impacts were assessed indirectly from the perspective of Manitoba surface water quality objectives (Williamson, 1983).

4.2 FIELD PROCEDURES

Basic field procedures were identical for all stations. Collection of samples was shared by staff of the Water Pollution Control Section and Water Standards and Studies Section.

Field temperatures and conductivities were determined on site using a Yellow Springs Instrument Company model #33 conductivity meter. Field pH was determined using a Canlab model #607 portable pH meter. Prelabelled sample containers and caps (excluding bacteria sample bottles and dissolved oxygen sample bottles) were triple rinsed on site with station water. Dissolved oxygen sample bottles were filled by using either a Kemmerer sampling bottle or a Wildco model #32407 sampler. All other sample containers were filled on site by submergence. Essential preservatives, where required (Sorba et al, 1980), were added on site. Filled sample containers were stored in coolers until delivery to the W. M. Ward Technical Services Laboratory. All samples were delivered within 12 hours of collection.

Prior to completion of the deep shaft sewage treatment facility, stations #1 to #3 were sampled at monthly intervals from October 18, 1978 to July 23, 1979. Sampling frequency was then doubled until January 6, 1981. Although the period January 28, 1980 to January 6, 1981 had been intended to be representative of the deep shaft sewage treatment facility operation, start-up difficulties and minor design modifications negated the value of accumulated data for the purposes of the study. Sampling was therefore discontinued until the system achieved full operational status. Bimonthly sampling of stations #1 to #4 recommenced on July 14, 1982 and continued until June 29, 1983.

Attempts to determine the extent of fish and wildlife useage of Gopher Creek were not made during the present study. However, some incidental observations were recorded. Initial attempts to record olfactory responses at various sites were discontinued when it became apparent that field personnel involved in the study possessed markedly different olfactory sensitivities.

4.3 ANALYTICAL PROCEDURES

Upon receipt of samples from stations #1 to #4, staff of the W. M. Ward Technical Services Laboratory commenced analyses according to procedures described by Sorba et al (1980). Laboratory staff also forwarded bacterial samples to the Cadham Provincial Laboratory for determination of total and fecal coliforms by the MPN method (Taras et al, 1971).

Data was segregated by sampling period with January 19, 1979 to December 11, 1979 deemed the pre-operational period and July 14, 1982 to May 3, 1983 deemed the operational period. Data prior to January 1, 1979 and from the operational development period (February 11, 1980 to January 6, 1981) was not treated in the present study because it was not applicable to study objectives. Data after May 3, 1983 was also excluded because minor system modifications necessitated a bypass of raw sewage. Segregated data was summarized on a sampling period and a site specific basis. Analysis of variance was performed on a sampling period basis for all stations in order to determine whether significant differences between stations occurred within each sampling period. Duncan's multiple range test was then

applied to differing parameters in order to identify the source(s) of difference. A student's "t" test was applied in order to determine whether site specific water quality had changed between sampling periods. All statistical procedures were tested at a 95% level of confidence.

Impacts upon water quality were also assessed indirectly by application of appropriate Manitoba surface water quality objectives (Williamson, 1983). Post operational conditions were then discussed within the context of pertinent objectives.

5. RESULTS AND DISCUSSION

Physicochemical data from each of the sampling periods are detailed in Appendices 1(a-c) to 2(a-d). Summaries of the pre-operational and operational sampling periods are presented in Tables 1 and 2, respectively. Pre-operational versus operational comparisons of water physicochemistry values per sampling station are presented in Table 3. Table 4 compares and ranks the mean water physicochemistry values between stations within each operating period.

5.1 SPECIFIC PARAMETERS

Specific conductance, or conductivity, is a measurement of water's capacity to conduct an electric current. This property, a function of temperature and the total concentration of ionized substances in the water, provides a general indication of the state of water purity with respect to dissolved minerals. The mean conductivity at station #1 was 3336 uS/cm during the pre-operational sampling period (Table 1) and 3325 uS/cm during the operational sampling period (Table 2). The difference was minor and not significant at $t \alpha = 0.05$ (Table 3). Mean conductivities at the treatment facility outfall (station #2) were lower than upstream values and ranged from 2238 uS/cm during the pre-operational sampling period (Table 1) to 2286 uS/cm during the operational sampling period (Table 2). The difference between sampling periods again was not significant (Table 3). Conductivities downstream of the outfall at

TABLE 1: SUMMARY OF PRE-OPERATIONAL PHYSICOCHEMICAL DATA

PARAMETER	STATION / STATISTIC	#1 (UPSTREAM) MEAN ± STANDARD DEVIATION	#2 (OUTFALL) MEAN ± STANDARD DEVIATION	#3 (PTH #1) MEAN ± STANDARD DEVIATION
Conductivity	µS/cm	3336. ± 1385.3	2238. ± 139.6	1960. ± 419.91
Total Residue	mg/L	2332. ± 958.3	1434. ± 81.2	1199. ± 217.8
Filterable Residue	mg/L	2318. ± 951.1	1332. ± 74.1	1170. ± 219.4
Non Filterable Residue	mg/L	17. ± 14.	102. ± 31.4	31. ± 17.
pH (Median)	Units	7.60	7.95	7.70
Dissolved Oxygen	mg/L	4.8 ± 3.89	3.8 ± 1.97	1.5 ± 3.39
BOD	mg/L	6.9 ± 4.61	159.4 ± 46.89	57.8 ± 33.58
Total Organic Carbon	mg/L	34.7 ± 7.44	187.5 ± 186.02	66.6 ± 17.7
Total Inorganic Carbon	mg/L	107.3 ± 52.39	156.2 ± 17.19	131.4 ± 46.0
Turbidity	NTU	5.82 ± 5.82	57.67 ± 46.52	20.32 ± 22.44
Total Kjeldhal Nitrogen	mg/L	2.00 ± 1.010	34.47 ± 10.827	22.15 ± 11.478
Ammonia	mg/L	0.63 ± 0.941	28.33 ± 5.437	19.05 ± 9.197
Dissolved Nitrogen	mg/L	0.08 ± 0.271	0.23 ± 0.395	0.10 ± 0.310
Total Phosphorus	mg/L	0.509 ± 0.377	8.467 ± 1.369	5.205 ± 2.302
Sodium	mg/L	361. ± 181.3	420. ± 26.8	326. ± 118.7
Chloride	mg/L	629. ± 326.6	269. ± 67.1	256. ± 65.6
Sulphate	mg/L	498. ± 169.4	65. ± 38.0	97. ± 76.4
Total Coliforms (Median)	MPN/100ml	1100.	G150,000	150,000
Fecal Coliforms (Median)	MPN/100ml	93.	150,000	150,000

TABLE 2: SUMMARY OF OPERATIONAL PHYSICOCHEMICAL DATA

PARAMETER	STATION / STATISTIC	#1 (UPSTREAM) MEAN ± STANDARD DEVIATION	#2 (OUTFALL) MEAN ± STANDARD DEVIATION	#3 (PTH #1) MEAN ± STANDARD DEVIATION	#4 (ASSINIBOINE RIVER) MEAN ± STANDARD DEVIATION
Conductivity	µS/cm	3325. ± 1739.53	2286. ± 75.43	2021. ± 683.05	1626. ± 523.57
Total Residue	mg/L	2245. ± 1201.2	1393. ± 51.7	1178 ± 346.1	982. ± 288.6
Filterable Residue	mg/L	2238. ± 1199.2	1329. ± 52.2	1168 ± 349.1	963. ± 302.2
Non Filterable Residue	mg/L	10. ± 4.4	6.9 ± 43.7	12.0 ± 9.0	20. ± 34.6
pH (Median)	Units	7.85	7.88	7.88	7.90
Dissolved Oxygen	mg/L	4.6 ± 4.33	7.2 ± 1.90	2.3 ± 2.81	7.0 ± 2.67
BOD	mg/L	6.7 ± 7.37	57.6 ± 45.59	19.3 ± 18.23	5.4 ± 4.91
Total Organic Carbon	mg/L	41.8 ± 23.09	88.2 ± 39.35	50.7 ± 24.92	34.3 ± 25.16
Total Inorganic Carbon	mg/L	127.9 ± 69.42	163.3 ± 24.17	143.7 ± 51.7	119.1 ± 44.6
Turbidity	NTU		33.45 ± 27.757	-	7.60 ± 2.535
Total Kjeldhal Nitrogen	mg/L	2.07 ± 0.797	35.10 ± 10.124	19.65 ± 10.419	10.58 ± 10.338
Ammonia	mg/L	0.54 ± 0.821	28.52 ± 6.053	17.52 ± 10.053	7.46 ± 9.460
Dissolved Nitrogen	mg/L	0.06 ± 0.113	3.14 ± 2.955	0.57 ± 0.803	0.94 ± 1.790
Total Phosphorus	mg/L	0.514 ± 0.371	7.095 ± 1.727	4.64 ± 2.00*	1.510 ± 1.685
Sodium	mg/L	388. ± 234.8	462. ± 49.0	358. ± 137.5	233. ± 120.7
Chloride	mg/L	672. ± 429.2	300. ± 23.5	248. ± 107.8	237. ± 83.0
Sulphate	mg/L	373. ± 212.7	64. ± 76.0	56. ± 21.1	40.0 ± 19.2
Total Coliforms (Median)	MPN/100ml	122	11,352	1968	244
Fecal Coliforms (Median)	MPN/100ml	31	88.	449	43

* An improbable value of 290 mg/L (February 23, 1983) was rejected from this and subsequent calculations on the basis of Dickson's Outlier Test (P = 0.95).

TABLE 3: PRE-OPERATIONAL VERSUS OPERATIONAL COMPARISONS ($t \alpha = 0.05$) OF SAMPLING STATION WATER PHYSICOCHEMISTRY

PARAMETER	STATION #1 (UPSTREAM)	STATION #2 (OUTFALL)	STATION #3 (PTH #1)
Conductivity	NS	NS	NS
Total Residue	NS	NS	NS
Filterable Residue	NS	NS	NS
Non Filterable Residue	NS	PREOPERATIONAL	PREOPERATIONAL
pH	NS	NS	OPERATIONAL
Dissolved Oxygen	NS	OPERATIONAL	NS
BOD	NS	PREOPERATIONAL	PREOPERATIONAL
Total Organic Carbon	NS	PREOPERATIONAL	PREOPERATIONAL
Total Inorganic Carbon	NS	NS	NS
Turbidity	-	NS	-
Total Kjeldhal Nitrogen	NS	NS	NS
Ammonia	NS	NS	NS
Dissolved Nitrate-Nitrite	NS	OPERATIONAL	OPERATIONAL
Total Phosphorus	NS	PREOPERATIONAL	NS
Sodium	NS	OPERATIONAL	NS
Chloride	NS	NS	NS
Sulphate	NS	NS	PREOPERATIONAL
Total Coliforms	NS	PREOPERATIONAL	PREOPERATIONAL
Fecal Coliforms	NS	PREOPERATIONAL	PREOPERATIONAL

NOTE: - "NS" denotes no significant difference in mean values between the preoperational and operational sampling periods.

- "PRE-OPERATIONAL" denotes that mean values during the pre-operational period were significantly greater ($t \alpha = 0.05$) than during the operational sampling period.

- OPERATIONAL" denotes that mean values during the operational period were significantly greater than during the pre-operational sampling period.

TABLE 4: COMPARISONS AND RANKING OF SAMPLING STATION MEAN WATER PHYSICOCHEMISTRY VALUES PER OPERATING PERIOD*

PARAMETER	PREOPERATIONAL**	OPERATIONAL**
Conductivity	123	1234
Total Residue	123	1234
Filterable Residue	123	1234
Non Filterable Residue	231	2431
pH	231	2431
Dissolved Oxygen	123	2413
BOD	231	2314
Total Organic Carbon	231	2314
Total Inorganic Carbon	231	2314
Turbidity	231	24
Total Kjeldhal Nitrogen	231	2341
Ammonia	231	2341
Dissolved Nitrate-Nitrite	231	2431
Total Phosphorus	231	2341
Sodium	213	2134
Chloride	123	1234
Sulphate	132	1234
Total Coliforms	231	3214
Fecal Coliforms	231	23 14

* Per Duncan's Multiple Range Test ($\alpha = 0.05$) where sampling stations are ranked from highest to lowest values and statistically indistinguishable sampling stations are underscored.

** Where station 1 is the upstream site;
station 2 is the treatment facility outfall;
station 3 is at PTH #1;
station 4 is near the confluence with the Assiniboine River.

station #3 were lower than the outfall values for each of the sampling periods. Conductivities varied from 1960 uS/cm to 2021 uS/cm (Tables 1 and 2, respectively) and were not significantly different (Table 3). The mean conductivity at station #4 was 1626 uS/cm during the operational sampling period (Table 2). Ranking of mean conductivities per sampling station for the pre-operational period indicated that a progressive decrease occurred from high values at station #1 to lower values at station #3 (Table 4). Ranking of mean conductivities for the operational sampling period indicated that a similar progressive decrease occurred (Table 4). However, in this comparison, a significant difference between station #2 and station #3 mean conductivities was not detected (Table 4). These results suggested that operation of the deep shaft sewage treatment facility did not significantly change the mean conductivity of Gopher Creek from pre-operational levels. Highly ionized waters upstream of the plant outfall continued to be diluted by discharges from the sewage treatment facility. Combined treatment facility discharges and Gopher Creek flows appeared further diluted as the confluence with the Assiniboine River was approached.

The term "filterable residue" refers to the total concentration of all dissolved minerals as well as those suspended materials able to pass through a GF/C glass fibre filter. Like specific conductance, this parameter also provides an indication of the general state of water purity. Mean filterable residues at station #1 during the pre-operational sampling period (2318 mg/L, Table 1) were not significantly different (Table 3) from mean values

of the operational sampling period (2238 mg/L, Table 2). Mean filterable residues at station #2, the treatment facility outfall, were lower than upstream values during each sampling period (1332 mg/L, Table 1; 1329 mg/L, Table 2; respectively). The difference between sampling periods was not significant at $t_{\alpha} = 0.05$ (Table 3). Mean filterable residues at station #3 decreased further to 1170 mg/L and 1178 mg/L for each of the sampling periods, respectively (Tables 1 and 2). The difference between sampling periods again was not significant (Table 3). Mean filterable residues at station #4 were 963 mg/L during the operational sampling period (Table 2). Ranking of mean filterable residues per sampling station for the pre-operational period indicated that a statistically significant progressive decrease occurred from high values at station #1 to lower values at station #3 (Table 4). Excepting that lowest values were present at station #4, an identical effect was achieved from ranking mean filterable residues of the operational sampling period (Table 4). These results were comparable to those of specific conductance and suggested that operation of the deep shaft sewage treatment facility did not significantly change mean filterable residue concentrations in Gopher Creek from pre-operational levels. Highly mineralized creek waters upstream of the facility outfall continued to be diluted by discharges from the sewage treatment facility and the combined flows appeared further diluted as the confluence with the Assiniboine River was approached.

The term "non filterable" residue refers to the concentration of particulates or suspended materials that are retained by a

GF/C glass fibre filter. Mean non filterable residue at station #1 during the pre-operational sampling period (17 mg/L, Table 1) was not significantly different (Table 3) than that of the operational sampling period (10 mg/L, Table 2). Mean non filterable residue at station #2 during the pre-operational sampling period (102 mg/L, Table 1) was, however, significantly greater (Table 3) than that discharged during operation of the deep shaft treatment facility (6.9 mg/L, Table 2). Similar significantly different results (Table 3) were observed at station #3 during the pre-operational (31 mg/L, Table 1) and the operational (12 mg/L, Table 2) sampling periods. Mean non filterable residues at station #4 were 20 mg/L (Table 2) during the operational sampling period. Ranking of mean non filterable residues per sampling station for the pre-operational sampling period indicated that concentrations at the treatment facility outfall (station #2) were significantly greater than both upstream (station #1) and downstream (station #3) concentrations and that station #3 concentrations were significantly greater than background (station #1) concentrations (Table 4). This meant that pre-operational treatment facility discharges were significantly increasing the load of suspended particulate matter in Gopher Creek. Ranking of mean non filterable residues per sampling station for the operational sampling period indicated that concentrations at station #2, the treatment facility outfall, continued to be significantly greater than concentrations at the other sampling stations (Table 4). However, concentrations at station #1, the background station, were not statistically distinguishable from

concentrations at stations #3 and #4 (Table 4). This meant that discharges from the deep shaft sewage treatment facility were not contributing significant amounts of suspended particulate matter to Gopher Creek. These results suggested that a significant improvement in mean non filterable residue concentrations downstream of the sewage treatment facility outfall were attributable to operation of the deep shaft treatment facility.

The term "total residue" refers to the sum of filterable and non filterable residues. However, because non filterable residues contributed less than 5% of the total residue concentrations at each station (Tables 1 and 2, respectively), total residue concentrations encountered during the present study were nearly indentical to filterable residue concentrations. Total residue results were therefore interpreted in the same way as filterable residue results.

The degree of acidity of water is indicated by pH units. Conventionally, neutral water has a pH of 7.0 units, acidic water less than 7.0 units and basic (alkaline) water greater than 7.0 pH units. The pH at all sampling stations was moderately alkaline (Appendices 1 and 2). Median pH values during the pre-operational sampling period ranged from 7.60 units at station #1 to 7.95 units and 7.70 units at stations #2 and #3, respectively (Table 1). Ranking of the pre-operational sampling period pH values indicated that stations #2 and #3 were statistically indistinguishable from each other and that the pH at both sites was significantly greater than that of station #1 (Table 4). These results suggested that discharges from the treatment facility prior to operation of the deep shaft

treatment facility caused a significant elevation of pH in Gopher Creek. Median pH values during the operational sampling period ranged from 7.85 units at station #1 to 7.88 units at stations #2 and #3 and 7.90 units at station #4 (Table 2). Ranking of the operational sampling period pH values indicated that all stations were statistically indistinguishable from each other. This confirms that discharges from the deep shaft sewage treatment facility were not significantly changing the pH values of Gopher Creek from background values.

Adequate dissolved oxygen concentrations are essential for the existence of aquatic organisms. Thus, dissolved oxygen levels provide an indication of the general "state of health" of a waterbody. During the pre-operational sampling period, mean dissolved oxygen concentrations ranged from 4.8 mg/L to 3.8 mg/L to 1.5 mg/L at stations #1, #2 and #3, respectively (Table 1). The mean dissolved oxygen concentrations at stations #1 and #2 were statistically indistinguishable from each other, but both were significantly greater than that of station #3 (Table 4). This suggested that a significant amount of organic matter was being loaded to Gopher Creek by pre-operational treatment facility discharges and that significant volumes of available dissolved oxygen were being utilized during the bacterial decomposition of the organic matter. During the operational sampling period, mean dissolved oxygen concentrations were 4.6 mg/L, 7.2 mg/L, 2.3 mg/L, and 7.0 mg/L for stations #1, #2, #3 and #4, respectively (Table 2). Mean concentrations at stations #2 and #4 were statistically indistinguishable from each other and both were

significantly greater than concentrations at stations #1 and #3 (Table 4). Mean dissolved oxygen concentrations in sewage treatment facility discharges at station #2 were significantly greater during the operational sampling period than during the pre-operational sampling period (Table 3). Significant differences were not detected between sampling periods at stations #1 and #3 (Table 3). These results implied that although substantial volumes of organic matter were still being discharged from the deep shaft treatment facility, higher concentrations of dissolved oxygen present in the discharge provided a greater capacity to accomodate organic loading and suggested a faster recovery of dissolved oxygen concentrations in lower reaches of Gopher Creek.

Biochemical oxygen demand or BOD, is defined as the quantity of oxygen required for biological and chemical oxidation of waterborne substances under specific test conditions. Within the context of the present study, the term BOD is considered to be virtually synonomous with organic loading. Mean BOD values during the pre-operational sampling period ranged from a station #1 background of 6.9 mg/L, to 159.4 mg/L and 57.8 mg/L at stations #2 and #3, respectively (Table 1). Mean values at each station differed significantly from that of other stations (Table 4). Mean BOD values during the operational sampling period ranged from 6.7 mg/L at station #1 to 57.6 mg/L, 19.3 mg/L and 5.4 mg/L at stations #2, #3 and #4, respectively (Table 2). Mean values at stations #1 and #4 were statistically indistinguishable from each other and both were significantly lower than mean values at stations #2 and #3 (Table 4).

Comparisons between sampling periods indicated that mean pre-operational BOD values were significantly greater than operational values at both stations #2 and #3, but that background values at station #1 evidenced no significant change (Table 3). These results suggested that operation of the deep shaft sewage treatment facility significantly reduced the level of BOD loading to Gopher Creek.

The term "total organic carbon", or TOC refers to a quantitative measurement of the carbon contained in the organic material present in water. Like BOD, TOC can provide an indication of organic loading. Mean TOC concentrations during the pre-operational sampling period ranged from 34.7 mg/L at station #1 to 187.5 mg/L and 66.6 mg/L at stations #2 and #3, respectively (Table 1). Although mean concentrations at station #3 were statistically indistinguishable from stations #1 and #2, station #2 concentrations were significantly greater than mean background concentrations at station #1 (Table 4). These results confirmed that significant quantities of organic matter were loaded to Gopher Creek by sewage treatment facility discharges during the pre-operational sampling period. Mean TOC concentrations during the operational sampling period ranged from a background of 41.8 mg/L at station #1 to 88.2 mg/L, 50.7 mg/L and 34.3 mg/L at stations #2, #3 and #4, respectively (Table 2). Mean concentrations at background and downstream stations (i.e. stations #1, #3 and #4) were statistically indistinguishable from each other and each was significantly lower than outfall mean concentrations at station #2 (Table 4). Comparisons between sampling periods indicated that a significant difference in mean TOC concentrations was not detected at

station #1 but that mean concentrations at stations #2 and #3 were significantly greater during the pre-operational sampling period. These results suggested that operation of the deep shaft sewage treatment facility resulted in a significant reduction in organic loading to Gopher Creek. These results were comparable to BOD results.

Total inorganic carbon, or TIC, refers to all other forms of carbon not associated with organic materials. Mean TIC concentrations during the pre-operational sampling period ranged from 107.3 mg/L at station #1 to 156.2 mg/L and 131.4 mg/L at stations #2 and #3, respectively (Table 1). Mean concentrations differed significantly between each of the stations (Table 4). Mean TIC concentrations during the operational sampling period ranged from 127.9 mg/L at station #1 to 163.3 mg/L, 143.7 mg/L and 119.1 mg/L at stations #2, #3 and #4, respectively (Table 2). Although mean concentrations at stations #2 and #3 were statistically indistinguishable and stations #3, #1 and #4 were statistically indistinguishable, mean concentrations at station #2 were significantly greater than mean concentrations at stations #1 and #4 (Table 4). However, because significant differences between sampling periods were not detected at any station (Table 3), the results were interpreted as indicative that operation of the deep shaft sewage treatment facility did not significantly alter the level of total inorganic carbon loading to Gopher Creek from pre-operational levels.

Turbidity is a measure of water clarity. It is a physical property related to the presence of suspended matter. Current speed can influence turbidity since swiftly flowing waters are capable of

suspending a greater particulate load than are still waters. Mean turbidities during the pre-operational sampling period ranged from 5.82 units (clear) at station #1 to 57.67 units (murky) and 20.32 units at stations #2 and #3, respectively (Table 1). Mean values were significantly different between each of the stations (Table 4). Turbidities were measured consistently only for samples from stations #2 and #4 during the operational sampling period. Mean values ranged from 33.45 units to 7.60 units for stations #2 and #4, respectively (Table 4). These means were significantly different from each other (Table 4). A significant difference was not detected between sampling periods at station #2 (Table 3). These results suggested that operation of the deep shaft sewage treatment facility had neither significantly improved nor reduced the clarity of discharges to Gopher Creek.

The term "total Kjeldhal nitrogen" refers to the total concentration of organically bound nitrogen present as measured by the Kjeldhal procedure. The organic nitrogen fraction in water is a product of biological processes and is composed of compounds such as amino acids. A rise in the organic nitrogen concentration may often be related to sewage discharges (Taras et al, 1971). Mean concentrations during the pre-operational sampling period ranged from 2.00 mg/L at station #1 to 34.47 mg/L and 22.15 mg/L at stations #2 and #3, respectively (Table 1). A significant difference was detected between each of the station means (Table 4). Mean concentrations during the operational sampling period ranged from 2.07 mg/L at station #1 to 35.10 mg/L, 19.65 mg/L and 10.58 mg/L at

stations #2, #3 and #4, respectively (Table 2). As during the pre-operational period, a significant difference was detected between each of the station means (Table 4). Comparisons between sampling periods indicated that a significant difference was not detected at any of the stations (Table 3). These results suggested that operation of the deep shaft sewage treatment facility did not significantly alter discharges of organic nitrogen to Gopher Creek.

Ammonia nitrogen is a product of microbiological activity and also of natural reduction processes. It is sometimes accepted as chemical evidence of sanitary pollution (Taras et al, 1971). During the pre-operational sampling period, mean ammonia concentrations ranged from 0.63 mg/L at station #1 to 28.33 mg/L and 19.05 mg/L at stations #2 and #3, respectively (Table 1). A significant difference was detected between each of the means (Table 4). During the operational sampling period mean ammonia concentrations ranged from 0.54 mg/L to 28.52 mg/L to 17.52 mg/L to 7.46 mg/L at stations #1, #2, #3 and #4, respectively (Table 2). Again, a significant difference was detected between each of the means (Table 4). Station specific comparisons between sampling periods indicated that significant differences were not present. These results suggested that operation of the deep shaft sewage treatment facility had not significantly reduced ammonia discharges to Gopher Creek.

Dissolved nitrogen present in the nitrate and nitrite forms is indicative of highly oxidized phases of the nitrogen reduction process. Nitrates and nitrites are derived from the reduction of more complex nitrogen compounds such as ammonia and amino acids

(i.e. organic nitrogen). When correlated with other forms of nitrogen, the dissolved phases may be indicative of organic pollution (Taras et al, 1971). During the pre-operational sampling period mean dissolved nitrogen concentrations ranged from 0.08 mg/L at station #1 to 0.23 mg/L and 0.10 mg/L at stations #2 and #3, respectively (Table 1). A significant difference between the means was not detected (Table 4). These results indicated that the significantly elevated (over background) organic and ammonia nitrogen loads discharged to Gopher Creek were not being oxidized to a significant degree during the pre-operational sampling period. During the operational sampling period mean dissolved nitrogen concentrations ranged from 0.06 mg/L at station #1 to 3.14 mg/L, 0.57 mg/L, and 0.94 mg/L at stations #2, #3 and #4, respectively (Table 2). Ranking of station means indicated that mean concentrations at station #2 were significantly greater than at all other stations, that stations #3 and #4 were statistically indistinguishable and that mean concentrations at station #1 were significanty lower than at all other stations (Table 4). Station specific comparisons between sampling periods indicated that mean dissolved nitrogen concentrations at stations #2 and #3 were significantly greater during the operational sampling period even though background concentrations at station #1 did not differ significantly (Table 3). These results suggested that operation of the deep shaft sewage treatment facility promoted a significant acceleration in oxidation of organic and ammonia nitrogen forms. However, the net effect was insufficient to significantly reduce the load of the more complex forms of nitrogen discharged to Gopher Creek.

Phosphorus, like nitrogen, is a nutrient essential for the growth and proliferation of aquatic life. Elevated levels of phosphorus in aquatic systems may be indicative of organic pollution (Taras et al 1971). During the pre-operational sampling period mean total phosphorus concentrations ranged from 0.509 mg/L at station #1 to 8.476 mg/L and 5.205 mg/L at stations #2 and #3, respectively (Table 1). A significant difference was detected between each of the means (Table 4). Mean total phosphorus concentrations during the operational sampling period ranged from 0.514 mg/L at station #1 to 7.095 mg/L, 4.64 mg/L, and 1.510 mg/L at stations #2, #3 and #4, respectively (Table 2). Again, significant differences were detected between each of the means. Station specific comparisons between sampling periods indicated that significant differences at stations #1 and #3 were not detected but that pre-operational discharges at station #2 were significantly greater than during the operational sampling period. This significant difference was thought to be an artifact because it was considered unlikely that the total phosphorus concentration present in sewage loaded to the treatment facility would have changed significantly between the two sampling periods. Thus, it was considered improbable that operation of the deep shaft sewage treatment facility could effect a significant change in the load of total phosphorus discharged to Gopher Creek.

Sodium is a common element present in most natural waters. During the pre-operational sampling period mean sodium concentrations ranged from 361 mg/L at station #1 to 420 mg/L and 326 mg/L at stations #2 and #3, respectively (Table 1). Although mean

concentrations at station #1 were statistically indistinguishable from that of stations #2 and #3, mean concentrations at station #2 were significantly greater than at station #3 (Table 4). This implied that sodium dilution had occurred downstream of the treatment facility outfall. During the operational sampling period, mean sodium concentrations ranged from 388 mg/L at station #1 to 462 mg/L, 358 mg/L and 233 mg/L at stations #2, #3 and #4, respectively (Table 2). Ranking of mean concentrations per sampling station were similar to the pre-operational period, excepting that mean concentrations at station #4 were significantly less than upstream concentrations (Table 4). Station specific comparisons between sampling periods indicated that mean concentrations of sodium were significantly greater at station #2 during the operational period. These results suggested that operation of the deep shaft sewage treatment facility was not significantly impacting upon sodium concentrations in Gopher Creek. The results also suggested that lower mean sodium concentrations in downstream reaches of Gopher Creek were attributable to some sodium dilution mechanism such as infiltration of groundwater.

Chloride is one of the major anions present in water and sewage (Taras et al 1971). Mean concentrations during the pre-operational sampling period ranged from 629 mg/L at station #1 to 269 mg/L and 256 mg/L at stations #2 and #3, respectively (Table 1). Mean concentrations at station #1 were significantly greater than downstream concentrations at stations #2 and #3 (Table 4). These results suggested that wastewater discharges from the sewage treatment

facility were effectively diluting chloride concentrations in Gopher Creek. Mean chloride concentrations during the operational sampling period ranged from 672 mg/L at station #1 to 300 mg/L, 248 mg/L and 237 mg/L at stations #2, #3 and #4, respectively (Table 2). Ranking of mean concentrations indicated that station #1 continued to have significantly greater mean chloride concentrations than all downstream stations (Table 4). Station specific comparisons between sampling periods failed to detect a significant difference. These results also suggested that discharges from the sewage treatment facility were diluting chloride concentrations in Gopher Creek. Evidence of significant dilution by groundwater infiltration was not detected.

Sulphate is common in natural waters; especially in waters drained from areas with high rates of evapotranspiration. Mean sulphate concentrations during the pre-operational sampling period ranged from 498 mg/L at station #1 to 65 mg/L and 97 mg/L at stations #2 and #3, respectively (Table 1). Mean concentrations at station #1 were significantly greater than downstream concentrations (Table 4). This suggested that discharges from the treatment facility effected a dilution of sulphate concentrations in Gopher Creek. Mean concentrations during the operational sampling period were similar to the pre-operational period and ranged from 373 mg/L at station #1 to 64 mg/L, 56 mg/L and 40 mg/L at stations #2, #3 and #4, respectively (Table 2). Again, mean concentrations at station #1 were significantly greater than downstream concentrations (Table 4). Station specific comparisons between sampling periods indicated that

mean concentrations at station #3 were significantly greater during the pre-operational period. However, this appeared to be an artifact and was not considered to be indicative of treatment facility impact.

The coliform group of bacteria has been used as a principal indicator of the suitability of water for various uses. Fecal coliform levels provide direct evidence of fecal contamination whereas total coliforms are of importance as a sensitive indicator of finished drinking water quality (Federal-Provincial Working Group on Recreational Water Quality, 1983). Background total coliform and fecal coliform median levels varied from 1100 to 93 organisms per 100 ml, respectively, during the pre-operational sampling period to 122 and 31 organisms per 100 ml, respectively, during the operational sampling period (Tables 1 and 2,). Comparisons between sampling periods failed to detect a significant difference at station #1 (Table 3). This suggested that background coliform contamination of Gopher Creek did not change significantly during the course of the present study. During the pre-operational sampling period, median concentrations of both total and fecal coliforms were estimated at 150,000 or more organisms per 100 ml at stations #2 and #3 (Table 1). Thus, discharges from the sewage treatment facility were indisputably the source of elevated coliform levels in the lower reaches of Gopher Creek during the pre-operational sampling period. During the operational sampling period median total coliform levels at stations #2, #3 and #4 were 11,532, 1968 and 244 organisms per 100 ml, respectively, while median fecal coliform levels were 88, 449 and 43 organisms per 100 ml, respectively (Table 2). Ranking of total and

fecal coliform concentrations indicated that although concentrations at stations #2 and #3 were significantly greater than background, concentrations at station #4 were statistically indistinguishable from background (Table 4). Station specific comparisons between sampling periods indicated that both total and fecal concentrations were significantly greater at stations #2 and #3 during the pre-operational sampling period (Table 3). These results suggested that operation of the deep shaft sewage treatment facility significantly reduced the concentrations of coliforms discharged to Gopher Creek from the treatment facility.

5.2 ASSESSMENT OF WATER QUALITY IN GOPHER CREEK

Assessment of impact is limited to a discussion of the water quality at stations #3 and #4 as delineated during the operational sampling period. This is because background physicochemistry at station #1 showed no significant change during the course of the present study and because station #2 at the facility outfall could not be considered a potential recreational waterbody. Although the present study included the parameters likely to be influenced by sewage discharges, assessment discussions were restricted to parameters having significant bearing upon local concerns. Local concerns included ensuring protection of water quality suitable for fish and wildlife habitat, livestock watering and primary recreation. Conditions in Gopher Creek during the operational sampling period were then compared to the pertinent criteria developed for these uses by Williamson (1983). These criteria are listed in Table 5.

Williamson (1983) cited a maximum conductivity of 4300 uS/cm as being the minimal quality necessary for protection of wildlife habitat and direct livestock watering. Mean conductivities at station #3 and #4 (2021 uS/cm and 1626 uS/cm, respectively; Table 2) were both well within the guidelines. Indeed, conductivities downstream of the deep shaft sewage treatment facility outfall were considerably improved over background. Clearly, the levels of conductivity discharged from the deep shaft facility posed no threat to downstream concerns.

TABLE 5: SPECIFIC WATER QUALITY REQUIREMENTS TO ENSURE PROTECTION OF FISH, WILDLIFE, LIVESTOCK AND RECREATIONAL INTERESTS IN GOPHER CREEK.

PARAMETER	SPECIFIC REQUIREMENTS*		
	2B	4D	5A
CONDUCTIVITY		4300 uS/cm	
FILTERABLE RESIDUE		3000 mg/L	
NON FILTERABLE RESIDUE	25 mg/L		
pH			6.5-8.5 units
DISSOLVED OXYGEN	47% saturation		
TURBIDITY			50 units
AMMONIA	0.02 mg/L (unionized)		
DISSOLVED NITRATE-NITRITE NITROGEN		10 mg/L	
SULPHATE		1000 mg.L*	
FECAL COLIFORMS		Geom. mean 1000 MPN/100 ml. (Ind. Max. 2000 MPN/100 ml.)	Geom. mean 200 MPN/100 ml. (Ind. Max. 400 MPN/100 ml.)

* Extracted from Williamson (1983) where classification 2B protects fish, 4D protects wildlife and livestock and 5A protects primary recreation.

** This value has subsequently been lowered to 600 mg/L (D. Williamson, pers. comm.).

A filterable residue level of 3000 mg/L was also cited (Williamson, 1983) as the maximum concentration acceptable for protection of wildlife habitat and direct livestock watering. Like conductivity, mean filterable residues at stations #3 and #4 (1168 mg/L and 963 mg/L, respectively; Table 2) were both well within the guidelines. It was evident that levels of filterable residues discharged from the deep shaft sewage treatment facility also posed no threat to downstream concerns.

A non filterable residue level of 25 mg/L was cited as the maximum concentration acceptable in order to ensure the protection of cool water fish species and other indigenous flora and fauna (Williamson, 1983). Mean non filterable residues at stations #3 and #4 (12 mg/L and 20 mg/L, respectively; Table 2) were both within the guidelines. However, there were several instances when the criteria were exceeded. Excessive non filterable residues at station #4 appeared unrelated to the deep shaft facility discharges because upstream values at station #3 were much lower on comparable sampling dates. Examples include November 30, 1982 and April 20, 1983 when station #4 values were 38 mg/L and 170 mg/L, respectively, and station #3 values were 13 mg/L and 30 mg/L, respectively (Appendices 2(c) and 2(d)). Personal observations at station #4 suggested that incidental excessive values were attributable to direct livestock watering and livestock feeding on site. Excessive levels at station #3, however, appeared attributable to discharges from the deep shaft sewage treatment facility. Thus it appeared that the deep shaft sewage treatment facility's occasional discharges of excessive

non filterable residues rendered downstream reaches of Gopher Creek near the outfall unsuitable for cool water fish species. Conditions further downstream were occasionally even more severe but were unrelated to facility discharges.

Although an appropriate pH range is also of importance to fish, wildlife and livestock concerns, requirements for the protection of primary recreation are the most stringent. A pH range of 6.5 to 8.5 units was cited as appropriate for the protection of primary recreational waters (Williamson, 1983). Maximum pH ranges at stations #3 and #4 were 7.55 to 8.15 units and 7.40 to 8.40 units, respectively (Appendices 2(c) and 2(d)). Thus the pH of discharges from the deep shaft sewage treatment facility was not detrimental to downstream uses.

The maintenance of aerobic conditions are necessary for protection of wildlife, livestock and recreational interests whereas protection of cool water aquatic organisms requires a minimum dissolved oxygen concentration of 47% saturation to permanently maintain all indigenous species of cool water aquatic organisms (Williamson, 1983). The frequent development of anaerobic conditions at station #3 indicated that downstream portions of Gopher Creek near the treatment facility outfall were also frequently unsuitable for wildlife usage, direct livestock watering and primary recreational activities. Because aerobic conditions were maintained in the station #4 reaches of Gopher Creek*, this lower area was considered suitable for wildlife useage, direct livestock watering and primary recreational activities.

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* The isolated development of anaerobic conditions on September 22, 1982 was considered an anomaly given other open water dissolved oxygen concentrations on site.

A turbidity of 50 units was cited as the maximum acceptable in order to ensure protection of primary recreational interests (Williamson, 1983). Mean turbidities of 33.45 units and 7.60 units at stations #2 and #4* (Table 2) suggested that the turbidity of discharges from the deep shaft sewage treatment facility posed no impairment to downstream concerns.

Williamson (1983) cited an un-ionized ammonia concentration of 0.02 mg/L as the maximum acceptable in order to ensure protection of cool water aquatic organisms. Occasionally, un-ionized ammonia concentrations substantially exceeded the criteria at both stations #3 and #4. Examples included November 4, 1982 and March 23, 1983 when calculated concentrations were 0.16 mg/L and 0.30 mg/L for stations #3 and #4, respectively. This suggested that reaches of Gopher Creek downstream of the treatment facility outfall were unsuitable for cool water aquatic organisms due to excessive un-ionized ammonia concentrations.

Williamson (1983 cited a dissolved nitrate-nitrite nitrogen concentration of 10 mg/L as the maximum acceptable in order to protect wildlife usage and direct livestock watering. Because mean concentrations at stations #3 and #4 were 0.57 mg/L and 0.94 mg/L, respectively (Table 2), dissolved nitrogen levels in discharges from the deep shaft sewage treatment facility posed no impairment to downstream wildlife usage and direct livestock watering.

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* Data unavailable for station #3.

A sulphate concentration of 1000 mg/L was cited (Williamson, 1983) as the maximum acceptable in order to protect wildlife usage and direct livestock watering. (This value has been revised downward to 600 mg/L (D. Williamson, pers. comm.)) Mean concentrations at station #3 and #4 were 65 mg/L and 40 mg/L, respectively (Table 2). Thus, sulphate levels in discharges from the deep shaft sewage treatment facility posed no impairment to downstream wildlife usage and direct livestock watering.

The most stringent criteria pertaining to fecal coliform levels concerned requirements for primary recreation (Williamson, 1983). Geometric mean fecal coliform levels were not to exceed 200 organisms per 100 ml. and individual maximums were not to exceed 400 organisms per 100 ml. (Ibid). The geometric mean at station #3 was calculated at 1426 organisms per 100 ml. and the individual maximums exceeded 150,000 organisms per 100 ml. on several occasions (Appendix 2(c)). These results suggested that downstream reaches of Gopher Creek near the treatment facility outfall were unsuitable for primary recreational purposes, for (monogastric) wildlife usage and for direct (monogastric) livestock watering. The geometric mean at station #4 was calculated at 41 organisms per 100 ml. and the individual maximum criteria was exceeded on two occasions (Appendix 2(d)). These results suggested that lower reaches of Gopher Creek in the vicinity of station #4 were suitable for wildlife usage and direct livestock watering but of marginal quality with respect to primary recreational activities. Little concern would be associated with recreational activities which exclude the possibility of accidental ingestion of water.

Although the water quality of downstream reaches of Gopher Creek was much improved over conditions during the pre-operational sampling period, inadequate dissolved oxygen levels and excessive un-ionized ammonia concentrations continued to inhibit the maintenance and propagation of sensitive cool water aquatic organisms. Downstream reaches of Gopher Creek near the treatment facility outfall were unsuitable for monogastric wildlife usage and direct monogastric livestock watering because of fecal coliform levels. Downstream reaches nearer the confluence with the Assiniboine River were suitable for wildlife usage and direct livestock watering. Because of fecal coliform levels, downstream reaches nearer the treatment facility outfall were unsuitable for primary recreational activities and downstream reaches nearer the confluence with the Assiniboine River were of marginal quality with respect to primary recreational activities.

6. CONCLUSIONS

It was concluded that:

1. Significant water quality improvements attributable to operation of the deep shaft sewage treatment facility were detected in concentrations of non filterable residues, dissolved oxygen, biochemical oxygen demand, total organic carbon, dissolved nitrate-nitrite nitrogen, total coliforms and fecal coliforms.
2. Significant water quality improvements attributable to operation of the deep shaft sewage treatment facility were not detected in conductivity, turbidity, pH and concentrations of total residues, filterable residues, total inorganic carbon, total Kjeldhal nitrogen, ammonia, total phosphorus, sodium, chloride and sulphate.
3. Inadequate dissolved oxygen levels and excessive un-ionized ammonia concentrations continued to inhibit the maintenance and propagation of sensitive cool water aquatic organisms in downstream reaches of Gopher Creek even after operation of the deep shaft sewage treatment facility.
4. Downstream reaches of Gopher Creek near the treatment facility outfall were unsuitable for monogastric wildlife usage, direct monogastric livestock watering and primary recreational activities because of excessive fecal coliform levels even after operation of the deep shaft sewage treatment facility.
5. Lower reaches of Gopher Creek nearer the confluence with the Assiniboine River were suitable for wildlife usage and direct livestock watering after operation of the deep shaft sewage treatment facility.

6. Because of fecal coliform levels, lower reaches of Gopher Creek nearer the confluence with the Assiniboine River were of marginal quality with respect to primary recreational activities.

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8. ACKNOWLEDGEMENTS

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APPENDIX 1

APPENDIX 1(a): Station 1 Pre-operational Physicochemical Data

DATE	TEMPERATURE (°CELSIUS)	COND. (US/CM)	T.R. (MG/L)	F.R. (MG/L)	N.F.R. (MG/L)	PH (UNITS)	SODIUM (MG/L)	DO (MG/L)
79 01 19	0.0	4630.0	3140.	3130.	14.	7.30	500.	<0.1
79 02 22	0.0	5190.0	3670.	3660.	10.	7.20	548.	<0.1
79 03 26	0.5	4860.0	3420.	3360.	60.	7.15	532.	<0.1
79 04 19	1.0	502.0	340.	330.	9.	7.60	35.	10.7
79 05 15	11.0	1040.0	790.	790.	5.	7.90	53.	9.6
79 06 19	18.0	1570.0	1120.	1120.	<5.	7.80	85.	5.8
79 07 23	21.5	2700.0	1930.	1930.	<5.	7.70	263.	9.6
79 08 07	18.0	2950.0	1990.	1980.	11.	7.60	297.	6.8
79 08 20	20.0	3620.0	2350.	2330.	16.	8.15	430.	7.9
79 09 04	19.0	3300.0	2230.	2210.	16.	7.95	355.	7.8
79 10 01	12.0	3420.0	2370.	2360.	12.	7.40	370.	2.1
79 10 15	8.0	2970.0	2380.	2370.	13.	7.50	390.	3.8
79 10 29	5.0	3480.0	2400.	2400.	14.	7.82	370.	8.3
79 11 12	2.0	4100.0	2828.	2800.	28.	7.61	448.	2.0
79 11 26	0.0	3910.0	2760.	2720.	35.	7.40	418.	2.5
79 12 11	0.0	5130.0	3600.	3590.	14.	7.40	680.	0.0

DATE	BOD (MG/L)	T.O.C. (MG/L)	T.I.C. (MG/L)	TURBIDITY (NTU)	TKN (MG/L)	NH3 (MG/L)	NO3-NO2 (MG/L)	P-TOTAL (MG/L)
79 01 19	10.0	43.5	173.0	7.00	3.30	1.52	0.03	0.900
79 02 22	9.0	38.0	187.0	5.00	3.80	2.00	0.01	1.000
79 03 26	10.0	51.0	190.0	20.00	4.40	3.35	0.01	1.200
79 04 19	8.0	24.0	16.5	5.00	1.40	0.31	1.10	0.420
79 05 15	5.0	34.5	53.5	0.85	1.00	<0.02	0.01	0.080
79 06 19	<3.0	38.5	83.5	1.50	1.30	0.07	0.02	0.240
79 07 23	4.0	28.5	96.0	0.35	1.20	0.02	0.01	0.130
79 08 07	<5.0	30.5	103.0	3.00	1.50	0.08	<0.01	0.260
79 08 20	3.0	35.0	86.5	3.00	1.50	0.03	<0.01	0.200
79 09 04	2.0	31.5	93.5	3.50	1.20	0.10	0.02	0.220
79 10 01	2.8	34.5	93.5	5.50	1.60	<0.02	0.02	0.320
79 10 15	7.2	27.0	111.0	3.50	1.60	0.35	0.02	0.440
79 10 29	15.0	--	--	5.00	2.10	0.10	<0.01	0.520
79 11 12	3.0	--	--	5.50	2.20	0.50	<0.01	0.720
79 11 26	5.0	--	--	20.00	1.40	0.46	0.04	0.290
79 12 11	18.0	--	--	4.50	2.50	1.20	0.01	1.200

APPENDIX 1(a): Station 1 Pre-operational Physicochemical Data, Continued

DATE	CHLORIDE (MG/L)	SULPHATE (MG/L)	T. COLI. (MPN/100 ML)	F. COLI. (MPN/100 ML)	FIELD PH (UNITS)	FIELD COND. (US/CM)
79 01 19	880.	632.	240	0	7.25	3600.
79 02 22	1050.	690.	75	4	7.15	5000.
79 03 26	970.	615.	1100	43	7.10	4600.
79 04 19	72.	60.	1500	240	6.90	430.
79 05 15	64.	245.	140	7	8.10	1100.
79 06 19	110.	336.	240	43	7.85	1550.
79 07 23	440.	466.	4600	4600	8.10	2800.
79 08 07	505.	476.	46000	46000	7.55	3000.
79 08 20	710.	600.	1100	93	7.65	3149.
79 09 04	580.	500.	11000	11000	7.65	3220.
79 10 01	650.	525.	--	--	7.35	3168.
79 10 15	660.	530.	4600	4600	7.75	2985.
79 10 29	660.	420.	1100	460	7.65	3454.
79 11 12	820.	590.	93	43	--	3897.
79 11 26	785.	565.	1100	150	7.15	3600.
79 12 11	1100.	715.	1500	75	7.65	4942.

APPENDIX 1(b): Station 2 Pre-operational Physicochemical Data

DATE	TEMPERATURE (°CELSIUS)	COND. (US/CM)	T.R. (MG/L)	F.R. (MG/L)	N.F.R. (MG/L)	PH (UNITS)	SODIUM (MG/L)	DO (MG/L)
79 01 19	8.5	2260.0	1480.	1390.	96.	8.00	445.	4.8
79 03 26	5.5	2240.0	1490.	1350.	118.	8.10	460.	5.4
79 04 19	6.0	1880.0	1280.	1190.	100.	8.05	370.	7.0
79 05 15	7.5	2070.0	1360.	1310.	54.	7.95	390.	5.8
79 07 23	17.0	2220.0	1480.	1370.	110.	7.10	381.	--
79 08 07	17.5	2270.0	1510.	1370.	140.	7.80	433.	2.2
79 08 20	17.0	2210.0	1380.	1290.	88.	7.95	422.	1.2
79 09 04	17.0	2480.0	1560.	1470.	92.	7.80	420.	2.3
79 09 17	18.0	2330.0	1460.	1380.	82.	7.80	445.	2.1
79 10 01	14.0	2300.0	1450.	1300.	150.	7.50	395.	2.0
79 10 15	8.5	2320.0	1450.	1390.	52.	7.80	440.	2.6
79 10 29	12.0	2090.0	1300.	1200.	110.	7.80	400.	5.2
79 11 12	10.0	2290.0	1500.	1340.	160.	8.10	432.	1.4
79 11 26	12.0	2340.0	1460.	1360.	104.	8.00	435.	5.5
79 12 11	5.0	2270.0	1350.	1270.	74.	8.15	438.	5.5

DATE	BOD (MG/L)	T.O.C. (MG/L)	T.I.C. (MG/L)	TURBIDITY (NTU)	TKN (MG/L)	NH3 (MG/L)	NO3-NO2 (MG/L)	P-TOTAL (MG/L)
79 01 19	160.0	130.0	160.0	200.00	45.00	28.50	0.71	10.000
79 03 26	110.0	150.0	190.0	55.00	31.00	24.50	0.21	7.500
79 04 19	165.0	108.0	133.0	70.00	27.00	15.60	1.40	6.000
79 05 15	90.0	110.0	145.0	30.00	29.00	24.00	0.45	7.000
79 07 23	175.0	124.0	142.0	35.00	7.00	25.50	0.49	8.000
79 08 07	180.0	165.0	171.0	25.00	38.00	26.80	0.01	9.500
79 08 20	106.0	120.0	145.0	100.00	40.00	28.50	0.02	8.500
79 09 04	145.0	130.0	142.0	30.00	32.00	25.00	0.01	8.000
79 09 17	236.0	131.0	171.0	30.00	34.50	25.00	0.01	9.000
79 10 01	159.0	746.0	151.0	25.00	42.50	32.50	0.02	8.500
79 10 15	G 220.0	149.0	168.0	35.00	20.00	35.50	0.01	10.000
79 10 29	130.0	--	--	100.00	35.50	30.50	0.01	6.500
79 11 12	217.0	--	--	40.00	46.50	36.00	<0.01	11.000
79 11 26	203.0	--	--	55.00	46.50	33.50	0.02	9.500
79 12 11	95.0	--	--	35.00	42.50	33.50	0.02	8.500

APPENDIX 1(b): Station 2 Pre-operational Physicochemical Data, Continued

DATE	CHLORIDE (MG/L)	SULPHATE (MG/L)	T. COLI. (MPN/100 ML)	F. COLI. (MPN/100 ML)	FIELD PH (UNITS)	FIELD COND. (US/CM)
79 01 19	300.	46.	G 150000	G 150000	8.05	1800.
79 03 26	290.	48.	G 150000	G 150000	8.45	2200.
79 04 19	250.	55.	G 150000	G 150000	7.80	1850.
79 05 15	280.	65.	G 150000	G 150000	8.10	2050.
79 07 23	300.	105.	G 150000	46000	7.85	2250.
79 08 07	285.	80.	G 150000	G 150000	7.90	2300.
79 08 20	305.	108.	G 150000	G 150000	7.60	2242.
79 09 04	32.	173.	G 150000	G 150000	7.85	2478.
79 09 17	280.	33.	G 150000	G 150000	8.15	2300.
79 10 01	275.	48.	--	--	7.85	2293.
79 10 15	290.	60.	G 150000	G 150000	8.15	2513.
79 10 29	285.	35.	G 150000	G 150000	7.95	2112.
79 11 12	300.	45.	G 150000	G 150000	--	2216.
79 11 26	295.	35.	G 150000	G 150000	7.95	2112.
79 12 11	275.	40.	G 150000	G 150000	8.40	2559.

APPENDIX 1(c): Station 3 Pre-operational Physicochemical Data

DATE	TEMPERATURE (°CELSIUS)	COND. (US/CM)	T.R. (MG/L)	F.R. (MG/L)	N.F.R. (MG/L)	PH (UNITS)	SODIUM (MG/L)	DO (MG/L)
79 01 19	0.0	2170.0	1290.	1270.	28.	7.70	388.	<0.1
79 02 22	0.0	2140.0	1300.	1270.	33.	7.75	400.	<0.1
79 03 26	2.0	2020.0	1220.	1190.	34.	7.65	378.	<0.1
79 04 19	1.0	803.0	550.	490.	56.	7.45	85.	9.1
79 05 15	12.0	1070.0	820.	820.	<5.	8.00	60.	9.8
79 06 19	18.0	1670.0	1110.	1110.	<5.	7.70	130.	0.7
79 07 23	20.0	2000.0	1260.	1230.	27.	7.85	319.	0.0
79 08 07	19.0	2170.0	1340.	1300.	39.	7.90	355.	0.0
79 08 20	22.0	2080.0	1120.	1080.	34.	8.10	402.	--
79 09 04	19.0	2240.0	1400.	1380.	21.	8.10	400.	--
79 09 17	16.0	2210.0	1320.	1280.	34.	7.65	405.	0.0
79 10 01	10.0	2320.0	1320.	1270.	56.	8.25	385.	0.0
79 10 15	12.5	2190.0	1330.	1310.	13.	7.80	390.	0.0
79 10 29	6.5	2090.0	1300.	1300.	22.	7.70	382.	0.0
79 11 12	2.0	1790.0	1076.	1060.	15.	7.70	258.	1.2
79 11 26	4.0	2190.0	1330.	1270.	65.	7.60	398.	--
79 12 11	0.0	2170.0	1290.	1260.	32.	7.50	412.	0.0

DATE	BOD (MG/L)	T.O.C. (MG/L)	T.I.C. (MG/L)	TURBIDITY (NTU)	TKN (MG/L)	NH3 (MG/L)	NO3-NO2 (MG/L)	P-TOTAL (MG/L)
79 01 19	82.0	80.5	163.0	30.00	33.00	26.00	0.04	6.500
79 02 22	60.0	71.0	155.0	25.00	27.00	23.00	0.02	6.000
79 03 26	55.0	81.0	170.0	25.00	23.50	20.80	0.01	5.500
79 04 19	38.0	39.5	23.5	15.00	2.70	0.68	1.30	0.700
79 05 15	5.0	36.5	55.5	1.50	1.80	0.55	0.10	0.280
79 06 19	6.0	37.5	89.5	2.00	4.80	3.50	0.08	1.000
79 07 23	33.0	58.5	141.0	7.00	3.80	15.00	0.01	4.500
79 08 07	40.0	79.5	155.0	10.00	23.50	20.00	<0.01	6.000
79 08 20	34.0	68.5	136.0	25.00	22.50	19.30	0.01	6.000
79 09 04	58.0	73.5	142.0	10.00	25.00	21.80	0.01	6.500
79 09 17	71.0	74.5	162.0	10.00	27.50	22.00	0.02	7.000
79 10 01	62.0	83.5	153.0	15.00	30.50	25.50	0.01	7.000
79 10 15	115.0	81.5	163.0	10.00	33.50	24.00	0.01	7.000
79 10 29	105.0	--	--	100.00	31.00	30.00	0.02	6.500
79 11 12	59.0	--	--	10.00	21.50	17.00	<0.01	4.500
79 11 26	121.0	--	--	30.00	34.00	28.30	0.03	7.000
79 12 11	38.0	--	--	20.00	31.00	26.50	0.03	6.500

APPENDIX 1(c): Station 3 Pre-operational Physicochemical Data, Continued

DATE	CHLORIDE (MG/L)	SULPHATE (MG/L)	T. COLI. (MPN/100 ML)	F. COLI. (MPN/100 ML)	FIELD PH (UNITS)	FIELD COND. (US/CM)
79 01 19	285.	48.	G 150000	G 150000	7.55	1850.
79 02 22	305.	45.	G 150000	G 150000	7.95	2000.
79 03 26	265.	35.	G 150000	G 150000	7.85	2000.
79 04 19	160.	75.	46000	15000	7.05	700.
79 05 15	73.	235.	G 150000	110000	8.15	1100.
79 06 19	160.	298.	290	43	7.70	1600.
79 07 23	280.	108.	G 150000	G 150000	8.50	2050.
79 08 07	310.	168.	G 150000	G 150000	8.00	2250.
79 08 20	290.	--	G 150000	G 150000	7.45	2014.
79 09 04	320.	143.	G 150000	G 150000	7.90	2373.
79 09 17	280.	60.	G 150000	G 150000	7.85	2169.
79 10 01	280.	50.	--	--	7.50	2146.
79 10 15	285.	55.	G 150000	G 150000	7.90	1200.
79 10 29	280.	48.	G 150000	G 150000	7.80	2042.
79 11 12	220.	73.	G 150000	G 150000	--	1864.
79 11 26	285.	58.	G 150000	G 150000	7.55	2093.
79 12 11	270.	58.	G 150000	G 150000	7.85	2382.

APPENDIX 2

APPENDIX 2(a): Station 1 Operational Physicochemical Data

DATE	TEMPERATURE (°CELSIUS)	COND. (US/CM)	T.R. (MG/L)	F.R. (MG/L)	N.F.R. (MG/L)	PH (UNITS)	SODIUM (MG/L)	DO (MG/L)
82 07 14	20.0	1980.0	1300.	1300.	<5.	8.35	206.	8.0
82 07 28	18.0	2420.0	1710.	1710.	<5.	8.35	249.	7.1
82 08 11	21.5	2580.0	1940.	1930.	6.	8.20	288.	1.0
82 08 25	20.8	2730.0	1770.	1760.	8.	8.30	336.	6.5
82 09 08	--	2950.0	2030.	2030.	<5.	8.15	356.	5.0
82 09 22	11.7	3210.0	2130.	2130.	<5.	7.95	320.	0.3
82 10 07	7.0	2920.0	1820.	1820.	<5.	8.00	320.	6.1
82 10 20	8.0	2920.0	1980.	1980.	<5.	8.10	345.	9.6
82 11 04	1.0	2080.0	1280.	1270.	10.	7.90	230.	9.7
82 11 17	3.2	2690.0	1680.	1670.	13.	8.00	303.	13.9
82 11 30	2.0	3480.0	2270.	2260.	15.	7.70	397.	4.6
82 12 15	0.5	4330.0	2920.	2910.	11.	7.50	478.	2.7
82 12 29	0.0	4710.0	3260.	3260.	9.	7.50	522.	0.0
83 01 12	0.0	5050.0	3410.	3400.	17.	7.50	580.	0.0
83 01 26	--	5730.0	3850.	3830.	13.	7.35	830.	0.0
83 02 09	--	6160.0	4310.	4290.	17.	7.20	844.	0.0
83 02 23	0.5	6240.0	4310.	4300.	11.	7.25	746.	0.0
83 03 09	--	4650.0	3250.	3240.	12.	7.25	566.	0.0
83 03 23	0.5	4970.0	3250.	3240.	10.	7.35	552.	0.0
83 04 07	0.5	352.0	240.	230.	13.	7.65	29.	8.8
83 04 20	7.7	287.0	220.	200.	18.	8.00	8.	8.3
83 05 03	9.3	718.0	470.	470.	<5.	7.80	39.	8.8

DATE	BOD (MG/L)	T.O.C. (MG/L)	T.I.C. (MG/L)	TURBIDITY (NTU)	TKN (MG/L)	NH3 (MG/L)	NO3-NO2 (MG/L)	P-TOTAL (MG/L)
82 07 14	2.6	29.5	76.0	--	1.30	0.06	<0.01	0.100
82 07 28	2.6	22.0	79.0	--	1.50	0.05	0.01	0.160
82 08 11	4.4	30.0	98.0	--	1.40	<0.02	<0.01	0.180
82 08 25	2.0	22.0	92.0	--	--	--	<0.01	0.180
82 09 08	<5.0	--	85.0	--	--	--	--	0.180
82 09 22	<5.0	--	--	1.50	1.60	<0.02	<0.01	0.240
82 10 07	<4.0	--	--	--	--	--	0.02	0.220
82 10 20	4.0	25.5	--	--	--	0.03	<0.01	0.320
82 11 04	4.5	25.0	78.0	--	1.50	0.02	<0.01	0.300

APPENDIX 2(a): Station 1 Operational Physicochemical Data, Continued

DATE	BOD (MG/L)	T.O.C. (MG/L)	T.I.C. (MG/L)	TURBIDITY (NTU)	TKN (MG/L)	NH3 (MG/L)	NO3-NO2 (MG/L)	P-TOTAL (MG/L)
82 11 17	7.4	53.5	83.0	--	2.40	0.02	<0.01	0.400
82 11 30	5.0	84.5	146.0	--	2.20	0.08	0.01	0.500
82 12 15	10.0	55.5	179.0	--	3.00	0.44	0.08	1.200
82 12 29	5.0	63.0	192.0	--	3.20	1.50	0.01	0.900
83 01 12	6.0	59.5	195.0	--	--	1.40	0.26	1.000
83 01 26	10.0	35.0	215.0	--	--	--	--	1.000
83 02 09	6.0	28.0	235.0	--	--	--	0.02	1.100
83 02 23	38.0	98.5	210.0	--	--	2.40	<0.01	1.000
83 03 09	5.0	31.0	185.0	--	--	--	--	0.800
83 03 23	10.0	62.5	190.0	--	3.50	2.10	<0.01	0.700
83 04 07	6.0	24.5	20.5	--	2.10	0.45	0.40	0.400
83 04 20	<3.0	26.0	25.0	--	--	0.05	0.26	0.300
83 05 03	2.5	19.0	47.0	--	1.20	0.02	<0.01	0.120

DATE	CHLORIDE (MG/L)	SULPHATE (MG/L)	T. COLI. (MPN/100 ML)	F. COLI. (MPN/100 ML)	FIELD PH (UNITS)	FIELD COND. (US/CM)
82 07 14	340.	250.	2179	1560	7.95	1879.
82 07 28	410.	285.	2135	1325	7.45	2875.
82 08 11	470.	300.	2914	1067	8.24	2333.
82 08 25	510.	375.	1353	823	--	--
82 09 08	570.	390.	1220	99	8.25	--
82 09 22	650.	385	512	512	--	--
82 10 07	530.	355.	330	217	8.13	2550.
82 10 20	540.	340.	116	54	7.30	1358.
82 11 04	360.	155.	28	28	8.10	3019.
82 11 17	530.	210.	54	34	7.80	2608.
82 11 30	650.	265.	158	3	7.70	3528.
82 12 15	830.	440.	680	185	7.40	3490.
82 12 29	940.	500.	109	28	7.00	4148.
83 01 12	1200.	515.	128	35	7.40	--
83 01 26	1350.	710.	28	6	--	--
83 02 09	1500.	610.	12	0	7.35	--
83 02 23	1400.	815.	12	3	7.35	--
83 03 09	920.	535.	20	3	--	--
83 03 23	1000.	640.	12	2	6.85	7713.
83 04 07	36.	17.	322	8	8.30	314.
83 04 20	7.	24.	23	17	7.50	--
83 05 03	48.	87.	9	9	1.18	804.

APPENDIX 2(b): Station 2 Operational Physicochemical Data

DATE	TEMPERATURE (°CELSIUS)	COND. (US/CM)	T.R. (MG/L)	F.R. (MG/L)	N.F.R. (MG/L)	PH (UNITS)	SODIUM (MG/L)	DO (MG/L)
82 07 14	25.2	2220.0	1360.	1310.	54.	7.85	460.	7.5
82 07 28	18.0	2240.0	1410.	1390.	18.	7.90	397.	6.5
82 08 11	--	2330.0	1380.	1350.	30.	7.85	420.	6.4
82 08 25	25.2	2370.0	1410.	1400.	15.	8.05	432.	7.0
82 09 08	--	2300.0	1390.	1360.	27.	7.75	456.	7.2
82 09 22	15.5	2450.0	1420.	1390.	30.	7.75	493.	0.0
82 10 07	16.0	2150.0	1270.	1210.	58.	7.85	416.	8.3
82 10 20	16.2	2310.0	1320.	1320.	21.	7.65	432.	8.0
82 11 30	11.0	2290.0	1360.	1330.	25.	7.85	468.	8.2
82 12 15	9.0	2320.0	1440.	1350.	88.	7.80	440.	9.6
82 12 29	8.0	2190.0	1360.	1310.	49.	7.70	408.	7.2
83 01 12	7.5	2210.0	1430.	1330.	100.	8.05	414.	8.1
83 01 26	--	2320.0	1440.	1350.	88.	8.10	560.	8.6
83 02 09	--	2340.0	1420.	1350.	71.	7.85	573.	7.1
83 02 23	7.0	2320.0	1490.	1350.	140.	7.90	450.	6.1
83 03 09	--	2300.0	1360.	1280.	76.	8.00	474.	8.3
83 03 23	7.5	2380.0	1370.	1280.	80.	8.15	494.	7.1
83 04 07	7.3	2170.0	1420.	1270.	150.	8.15	526.	7.4
83 04 20	7.6	2250.0	1340.	1240.	100.	8.10	490.	8.5
83 05 03	8.0	2250.0	1460.	1400.	150.	8.00	434.	7.1

DATE	BOD (MG/L)	T.O.C. (MG/L)	T.I.C. (MG/L)	TURBIDITY (NTU)	TKN (MG/L)	NH3 (MG/L)	NO3-NO2 (MG/L)	P-TOTAL (MG/L)
82 07 14	35.0	50.0	155.0	10.00	23.00	23.00	7.00	8.000
82 07 28	23.0	40.0	162.0	9.50	23.50	20.50	7.10	5.400
82 08 11	19.0	43.0	166.0	8.00	17.50	15.00	10.00	4.100
82 08 25	14.5	56.5	137.0	10.00	24.00	21.50	5.90	10.200
82 09 08	26.0	--	165.0	10.00	28.50	28.00	5.70	.800
82 09 22	23.0	--	--	10.00	35.00	30.50	2.70	.700
82 10 07	27.0	--	--	20.00	23.00	23.00	5.40	4.000
82 10 20	11.0	34.5	--	7.50	27.50	26.50	6.50	4.600
82 11 30	30.0	62.0	187.0	9.00	32.00	26.00	2.50	5.600
82 12 15	14.0	88.0	193.0	30.00	37.00	35.50	0.14	8.600

APPENDIX 2(b): Station 2 Operational Physicochemical Data, Continued

DATE	BOD (MG/L)	T.O.C. (MG/L)	T.I.C. (MG/L)	TURBIDITY (NTU)	TKN (MG/L)	NH3 (MG/L)	NO3-NO2 (MG/L)	P-TOTAL (MG/L)
82 12 29	26.0	89.5	88.5	15.00	30.50	24.50	0.56	5.800
83 01 12	90.0	96.5	164.0	35.00	41.00	29.00	1.30	7.500
83 01 26	170.0	108.0	174.0	50.00	44.50	34.00	0.92	8.100
83 02 09	65.0	91.5	185.0	30.00	41.00	33.00	0.65	7.800
83 02 23	100.0	87.0	165.0	75.00	43.50	30.50	0.67	8.400
83 03 09	98.0	87.5	183.0	40.00	47.00	37.50	0.60	7.300
83 03 23	110.0	119.0	181.0	75.00	54.00	38.00	0.72	8.100
83 04 07	130.0	148.0	150.0	60.00	41.50	29.50	1.40	7.600
83 04 20	G 70.0	119.0	155.0	75.00	40.50	31.50	1.70	8.000
83 05 03	70.0	180.0	165.0	90.00	47.50	33.50	1.30	9.300

DATE	CHLORIDE (MG/L)	SULPHATE (MG/L)	T. COLI. (MPN/100 ML)	F. COLI. (MPN/100 ML)	FIELD PH (UNITS)	FIELD COND. (US/CM)
82 07 14	300.	50.	91218	3762	7.95	1648.
82 07 28	280.	38.	285	35	--	2231.
82 08 11	260.	100.	G 150000	G 150000	--	--
82 08 25	330.	130.	148	114	--	--
82 09 08	320.	37.	21075	14	7.65	--
82 09 22	320.	35.	205	28	--	--
82 10 07	270.	30.	31662	9574	7.90	2049.
82 10 20	290.	41.	21	3	6.89	2100.
82 11 30	310.	46.	25	2	7.89	2160.
82 12 15	300.	41.	549	62	7.55	2272.
82 12 29	280.	41.	84	14	7.65	2190.
83 01 12	290.	38.	1582	58	7.85	--
83 01 26	330.	35.	16	5	--	--
83 02 09	310.	35.	G 150000	G 150000	7.40	--
83 02 23	310.	370.	34085	1151	8.15	--
83 03 09	390.	43.	G 150000	135267	--	--
83 03 23	340.	36.	22985	12198	7.85	3540.
83 04 07	300.	42.	1629	62	7.85	2085.
83 04 20	250.	40.	G 150000	121981	7.30	--
83 05 03	300.	45.	G 150000	G 150000	8.16	2015.

APPENDIX 2(c): Station 3 Operational Physicochemical Data

DATE	TEMPERATURE (°CELSIUS)	COND. (US/CM)	T.R. (MG/L)	F.R. (MG/L)	N.F.R. (MG/L)	PH (UNITS)	SODIUM (MG/L)	DO (MG/L)
82 07 14	20.5	2070.0	1220.	1220.	<5.	8.00	355.	0.8
82 07 28	18.0	1960.0	1220.	1210.	7.	8.15	325.	0.9
82 08 11	21.5	2130.0	1330.	1320.	7.	8.05	379.	0.1
82 08 25	21.0	2210.0	1320.	1320.	<5.	8.10	424.	1.2
82 09 08	--	3460.0	1430.	1430.	<5.	8.15	412.	5.6
82 09 22	13.0	2400.0	1450.	1450.	<5.	8.00	446.	0.0
82 10 07	7.5	2090.0	1230.	1230.	<5.	7.90	363.	0.8
82 10 20	7.0	2050.0	1250.	1250.	<5.	7.95	360.	2.9
82 11 04	1.0	2020.0	1190.	1180.	9.	7.90	370.	3.3
82 11 17	1.2	2130.0	1220.	1220.	<5.	7.85	385.	2.8
82 11 30	1.0	2310.0	1380.	1360.	13.	7.80	464.	3.4
82 12 15	0.0	2350.0	1390.	1380.	8.	7.60	446.	4.1
82 12 29	2.0	2320.0	1380.	1380.	7.	7.70	410.	0.0
83 01 12	0.0	2260.0	1350.	1330.	21.	7.65	386.	0.0
83 01 26	--	2320.0	1360.	1330.	26.	7.80	530.	0.0
83 02 09	--	2310.0	1370.	1350.	24.	7.65	467.	0.0
83 02 23	2.0	2120.0	1270.	1250.	28.	7.65	385.	0.0
83 03 09	--	2230.0	1280.	1260.	21.	7.55	422.	1.0
83 03 23	0.5	2170.0	1210.	1210.	5.	7.80	422.	0.0
83 04 07	0.5	488.0	320.	300.	21.	8.00	57.	7.8
83 04 20	7.4	294.0	240.	210.	30.	8.00	8.	8.2
83 05 03	10.0	759.0	500.	500.	<5.	7.80	52.	8.0

DATE	BOD (MG/L)	T.O.C. (MG/L)	T.I.C. (MG/L)	TURBIDITY (NTU)	TKN (MG/L)	NH3 (MG/L)	NO3-NO2 (MG/L)	P-TOTAL (MG/L)
82 11 04	3.4	22.5	141.0	--	18.00	18.00	1.50	3.800
82 11 17	5.0	51.5	142.0	--	19.50	19.50	3.10	4.200
82 11 30	15.0	91.5	190.0	--	26.00	21.00	2.00	5.300
82 07 14	4.7	40.5	135.0	--	--	18.00	0.61	6.800
82 07 28	11.0	29.5	146.0	--	--	14.00	0.76	6.400
82 08 11	21.00	42.5	166.0	--	15.00	11.80	0.38	5.200
82 08 25	15.0	31.5	159.5	--	--	--	0.02	5.200
82 09 08	11.0	--	171.0	--	--	--	--	4.600
82 09 22	9.5	--	--	1.50	22.50	21.00	0.24	6.200
82 10 07	5.4	--	--	--	--	--	0.21	4.800
82 10 20	<4.0	25.5	--	--	--	--	0.37	4.000

APPENDIX 2(c): Station 3 Operational Physicochemical Data, Continued

DATE	BOD (MG/L)	T.O.C. (MG/L)	T.I.C. (MG/L)	TURBIDITY (NTU)	TKN (MG/L)	NH3 (MG/L)	NO3-NO2 (MG/L)	P-TOTAL (MG/L)
82 12 15	11.0	54.5	195.0	--	27.50	27.50	0.49	5.700
82 12 29	16.0	72.0	160.0	--	30.50	27.00	0.01	6.000
83 01 12	40.0	63.0	172.0	--	--	28.00	0.38	6.100
83 01 26	50.0	80.0	165.0	--	--	--	--	6.500
83 02 09	36.0	54.0	185.0	--	--	--	0.02	6.200
83 02 23	48.0	96.5	160.0	--	--	24.50	<0.01	290.000*
83 03 09	64.0	83.0	148.0	--	--	--	--	5.000
83 03 23	40.0	57.5	190.0	--	32.00	0.16	<0.01	5.600
83 04 07	8.0	24.5	27.5	--	3.50	1.70	0.43	0.600
83 04 20	<3.0	21.5	25.0	--	--	0.09	0.27	0.400
83 05 03	4.0	21.0	51.5	--	2.00	0.69	0.08	0.300

DATE	CHLORIDE (MG/L)	SULPHATE (MG/L)	T. COLI. (MPN/100 ML)	F. COLI. (MPN/100 ML)	FIELD PH (UNITS)	FIELD COND. (US/CM)
82 07 14	290.	63.	197	34	--	1993.
82 07 28	240.	55.	202	57	--	2208.
82 08 11	260.	78.	468	99	7.95	1926.
82 08 25	300.	120.	6372	1860	--	--
82 09 08	320.	65.	1500	114	8.12	--
82 09 22	340.	84.	400	158	--	--
82 10 07	260.	43.	1353	474	7.94	1991.
82 10 20	270.	54.	2005	370	7.34	1890.
82 11 04	260.	53.	756	38	8.10	2243.
82 11 17	280.	57.	370	34	7.75	2052.
82 11 30	305.	53.	3703	423	7.90	2070.
82 12 15	320.	52.	73434	18504	7.50	1147.
82 12 29	310.	50.	G 150000	121981	8.00	2268.
83 01 12	300.	59.	G 150000	G 150000	7.50	--
83 01 26	320.	46.	G 150000	G 150000	--	--
83 02 09	320.	44.	G 150000	G 150000	7.25	--
83 02 23	6.	43.	82259	37032	8.00	--
83 03 09	330.	40.	135267	8468	--	--
83 03 23	310.	42.	G 150000	G 150000	7.35	3560.
83 04 07	64.	21.	208	20	8.35	379.
83 04 20	7.	25.	37	28	7.50	--
83 05 03	55.	80.	1931	798	8.05	748.

*Suspect value excluded from calculations on the basis of Dickson's Outlier Test (p = 0.95).

APPENDIX 2(d): Station 4 Operational Physicochemical Data

DATE	TEMPERATURE (°CELSIUS)	COND. (US/CM)	T.R. (MG/L)	F.R. (MG/L)	N.F.R. (MG/L)	PH (UNITS)	SODIUM (MG/L)	DO (MG/L)
82 07 14	20.9	1340.0	800.	790.	14.	8.15	159.	7.5
82 07 28	18.0	1360.0	840.	830.	13.	8.40	158.	9.4
82 08 11	21.5	1400.0	850.	830.	18.	8.20	185.	5.0
82 08 25	21.0	1370.0	780.	775.	7.	8.25	167.	6.4
82 09 08	--	1340.0	830.	800.	26.	8.10	153.	7.0
82 09 22	11.3	1400.0	820.	810.	10.	8.00	141.	0.0
82 10 07	7.0	1510.0	890.	890.	<5.	8.05	184.	7.8
82 10 20	7.5	1520.0	920.	920.	<5.	8.20	200.	10.9
82 11 04	4.0	2240.0	1330.	1300.	31.	7.95	460.	6.0
82 11 17	2.0	2090.0	1250.	1210.	38.	7.80	436.	8.6
82 11 30	1.0	2310.0	1380.	1360.	15.	7.85	460.	3.3
82 12 15	0.5	1970.0	1330.	1320.	6.	7.70	265.	9.3
82 12 29	1.0	2170.0	1310.	1300.	13.	7.40	298.	7.4
83 01 12	0.0	2030.0	1240.	1230.	13.	7.70	279.	6.7
83 01 26	--	1800.0	1060.	1050.	8.	7.65	240.	6.4
83 02 09	--	1890.0	1090.	1080.	10.	7.65	234.	2.9
83 02 23	0.5	2320.0	1360.	1350.	5.	7.70	367.	6.4
83 03 09	--	1850.0	1090.	1080.	12.	7.65	290.	7.4
83 03 23	0.0	1880.0	990.	980.	8.	7.60	280.	5.6
83 04 07	--	884.0	540.	530.	10.	7.65	112.	11.4
83 04 20	7.7	307.0	400.	230.	170.	7.95	10.	10.0
83 05 03	9.0	786.0	510.	510.	<5.	8.05	59.	9.0

DATE	BOD (MG/L)	T.O.C. (MG/L)	T.I.C. (MG/L)	TURBIDITY (NTU)	TKN (MG/L)	NH3 (MG/L)	NO3-NO2 (MG/L)	P-TOTAL (MG/L)
82 07 14	3.5	19.0	91.0	--	0.90	0.06	0.01	0.360
82 07 28	5.0	18.5	91.0	--	1.30	0.02	0.01 L	0.520
82 08 11	4.6	25.5	104.0	--	1.10	0.02 L	0.08	0.400
82 08 25	2.2	14.0	100.0	--	--	--	--0.01 L	0.400
82 09 08	5.5	--	88.0	--	--	--	--	0.320
82 09 22	<5.0	--	--	4.00	0.80	0.03	<0.01	0.320
82 10 07	5.4	--	--	--	--	--	0.19	0.400
82 10 20	<4.0	13.5	--	--	--	<0.02	<0.01	0.400
82 11 04	9.0	35.0	145.0	10.00	29.00	29.00	4.50	5.600
82 11 17	21.0	90.0	148.0	10.00	20.50	19.00	6.70	4.000

APPENDIX 2(d): Station 4 Operational Physicochemical Data, Continued

DATE	BOD (MG/L)	T.O.C. (MG/L)	T.I.C. (MG/L)	TURBIDITY (NTU)	TKN (MG/L)	NH3 (MG/L)	NO3-NO2 (MG/L)	P-TOTAL (MG/L)
82 11 30	18.0	78.0	185.0	--	26.00	22.00	1.90	5.400
82 12 15	5.0	26.5	165.0	--	16.50	2.60	0.48	0.500
82 12 29	2.0	37.0	165.0	7.50	7.60	6.90	0.60	1.550
83 01 12	4.0	22.5	147.0	6.50	9.50	8.40	0.68	2.100
83 01 26	1.0	19.0	125.0	--	--	--	--	0.700
83 02 09	2.0	13.0	140.0	--	--	--	0.43	0.400
83 02 23	5.0	82.0	160.0	--	--	11.00	0.44	2.800
83 03 09	5.0	66.5	138.0	--	--	--	--	2.800
83 03 23	3.0	22.0	147.0	--	12.50	12.50	0.34	2.800
83 04 07	<3.0	36.0	47.5	--	--	--	--	0.700
83 04 20	<3.0	19.5	25.0	--	--	0.14	0.27	0.500
83 05 03	2.0	14.5	51.5	--	1.30	0.25	0.32	0.260

DATE	CHLORIDE (MG/L)	SULPHATE (MG/L)	T. COLI. (MPN/100 ML)	F. COLI. (MPN/100 ML)	FIELD PH (UNITS)	FIELD COND. (US/CM)
82 07 14	210.	31.	102	42	7.75	1263.
82 07 28	210.	23.	798	44	7.60	1495.
82 08 11	210.	18.	4234	51	8.19	1273.
82 08 25	220.	10.	271	111	--	--
82 09 08	220.	10.	1500	1500	8.07	--
82 09 22	210.	5.	217	77	--	--
82 10 07	220.	30.	202	24	8.10	1425.
82 10 20	220.	47.	72	11	7.30	1387.
82 11 04	290.	43.	361	34	8.05	2657.
82 11 17	280.	41.	5	0	7.55	2554.
82 11 30	305.	44.	4359	370	8.15	1639.
82 12 15	330.	70.	17	2	7.65	1920.
82 12 29	320.	63.	1235	370	7.00	2070.
83 01 12	300.	59.	5	4	7.75	--
83 01 26	270.	49.	5	2	--	--
83 02 09	280.	47.	117	34	7.30	--
83 02 23	350.	58.	73	31	8.00	--
83 03 09	270.	42.	144	52	--	--
83 03 23	290.	47.	1067	1067	7.25	3089.
83 04 07	135.	41.	642	25	--	--
83 04 20	9.	27.	336	52	7.70	--
83 05 03	64.	75.	354	354	8.25	767.

APPENDIX 3

315 - 401 YORK AVE., WINNIPEG 1
TELEPHONE 946-7378 - 946-7965

November 15th, 1971.

INTERIM LICENCE - TOWN OF VIRDEN,
Province of Manitoba.

This licence is issued pursuant to the Clean Environment Act permitting the Town of Virden, Province of Manitoba, to discharge contaminants or wastes into the Gopher Creek arising from the operation of a municipal sewage system serving the Town of Virden, Manitoba, subject to the following conditions:

(1) The licensee shall ensure that definite proposals as to the site and type of plant, the sites of discharge and the quality of the effluent and the date of completion are submitted to the Clean Environment Commission not later than January 1st, 1972.

(2) The licensee shall ensure that the construction of the new treatment facility is commenced, as soon as possible, and in any case not later than July 1st, 1972.

This licence is issued for a period of one year from the date of issuance.

Chairman,
CLEAN ENVIRONMENT COMMISSION.

458

July 3/75

AN ORDER OF THE CLEAN ENVIRONMENT COMMISSION

UNDER THE CLEAN ENVIRONMENT ACT

RE: THE CLEAN ENVIRONMENT COMMISSION and the TOWN OF VIRDEN, Applicant,

WHEREAS pursuant to the provisions of The Clean Environment Act, the Town of Virden filed a proposal with the Department of Mines, Resources and Environmental Management in connection with the operation of an existing sewage treatment system located in Lot 6, Block 170, Plan 197 in the Town of Virden, Manitoba, with discharge of effluent to the waters of Gopher Creek;

AND WHEREAS in the absence of limits being prescribed by a Regulation under the said Act, the proposal was referred to The Clean Environment Commission for the prescribing of limits;

AND WHEREAS the said Commission received a notice of representation from a person who is or who is likely to be affected by an Order of the Commission prescribing limits in connection with the said operation;

AND WHEREAS the said Commission held a public hearing in the Courtroom of the Municipal Hall in Virden, Manitoba, on the 3rd day of March, 1975;

AND WHEREAS evidence heard at the said public hearing indicated that the effluent from the said existing sewage treatment system had created, or substantially contributed to, a nuisance condition exisring in the said Creek;

AND WHEREAS the said Commission considered the said proposal on the 26th day of May, 1975;

AND WHEREAS the said Commission is of the opinion that limits should be prescribed in respect to the said existing sewage treatment system, and that the sewage treatment and disposal system in the Town of Virden be upgraded at the earliest practical date;

IT IS HEREBY ORDERED THAT

1. The Applicant shall, in connection with the existing primary sewage treatment plant, ensure that:

(a) the said primary treatment plant is so maintained and operated as to:

(i) minimize the release of offensive odours at the said primary plant site and along the route of the watercourse of the said Gopher Creek; and

(ii) control any nuisance condition at the said primary plant site or along the said route of the Gopher Creek watercourse: and

(iii) provide for the removal of sludge every two months and the innocuous disposal of the removed sludge;

(b) the effluent, as discharged, is subjected to continuous chlorination sufficient to provide at any time a residual of not less than 0.5 milligrams per litre of chlorine, after 15 minutes contact;

(c) after the 31st day of December, 1975, the effluent, before chlorination and discharge, is subject to continuous aeration for a minimum period of twenty days.

IT IS HEREBY FURTHER ORDERED THAT

2. The Applicant shall, within 6 months of the date of issuance of this Order, file with the Department of Mines, Resources and Environmental Management - with a copy to The Clean Environment Commission - a proposal relating to the upgrading and improvement of the sewage treatment and disposal system of the Town of Virden in conformity with the following:

(a) the proposal to be based on engineering design, construction and setting in operation on or before the 31st day of December, 1976;

(b) the design, construction and operational effectiveness to be adequate to produce an effluent in which, before any chlorination:

(i) the average 5-day biochemical oxygen demand is not in excess of 30 milligrams per litre; and

(ii) the total coliform content, as indicated by the "MF" index, is not in excess of 1500 per 100 millilitres of sample;

(c) provision to be made for the continuous chlorination of the effluent as discharged sufficient to provide at any time a residual of not less than 0.5 milligrams per litre of chlorine, after 15 minutes contact;

(d) the route of effluent and final disposal to be:

(i) either by enclosed pipeline with continuous discharge directly to the waters of the Assiniboine River;

2.(d) Cont'd

or(ii) by enclosed pipeline or open conduit intermittently to the watercourse of the Gopher Creek: this alternative to include provisions for winter and summer storage of effluent and discharge only during the Spring high-flow period of Gopher Creek and possible selective discharge during the Fall of each year.

3. The Applicant shall proceed to implement the proposal or the alternate proposal and set the improved and upgraded sewage treatment and disposal system in operation on or before the 31st day of December, 1976.

Order No. 458

Dated at the City of Winnipeg

this 3rd day of JULY, 1975.

E. B. Moore

Chairman,
Clean Environment Commission

458VC
April 9/76

AN ORDER OF THE CLEAN ENVIRONMENT COMMISSION

UNDER THE CLEAN ENVIRONMENT ACT

RE: THE CLEAN ENVIRONMENT COMMISSION and the TOWN OF VIRDEN, Applicant,

WHEREAS pursuant to the provisions of The Clean Environment Act, the Town of Virden filed an application with the Department of Mines, Resources and Environmental Management in connection with the operation of an existing sewage treatment system located in Lot 6, Block 170, Plan 197 in the Town of Virden, Manitoba, with discharge of effluent to the waters of Gopher Creek;

AND WHEREAS in the absence of limits being prescribed by a Regulation under the said Act, the proposal was referred to The Clean Environment Commission for the prescribing of limits;

AND WHEREAS the Commission received a notice of representation from a person who is or who is likely to be affected by an Order of the Commission prescribing limits in connection with the said operation;

AND WHEREAS the Commission held a public hearing in Virden, Manitoba, on the 3rd day of March, 1975;

AND WHEREAS evidence heard at the said public hearing indicated that the effluent from the said existing sewage treatment system had created, or substantially contributed to, a nuisance condition existing in the said Creek;

AND WHEREAS the Commission considered the application on the 26th day of May, 1975, and issued Order No. 458 on the 3rd day of July, 1975;

AND WHEREAS the Commission was of the opinion that the sewage treatment and disposal system in the Town of Virden should be upgraded at the earliest practical date;

. . . . 2

AND WHEREAS an appeal from that Order was filed with the Minister by the Town of Virden on the 30th day of July, 1975, who referred the matter to the Commission because new evidence indicated that rather than an appeal, the submission was a request for a variation to the Order;

AND WHEREAS the Commission held a public hearing on the 5th day of April, 1976, in Virden, Manitoba to consider a possible variation under Section 14(7) of The Clean Environment Act;

AND WHEREAS at the said hearing the Town of Virden submitted a proposal for the construction and setting into operation a mechanical sewage treatment plant with an effluent outfall pipe terminating in the Assiniboine River;

AND WHEREAS the Commission considered the proposal and evidence submitted at the hearing on the 5th day of April, 1976;

IT IS HEREBY ORDERED THAT ORDER NO. 458 BE VARIED TO READ AS FOLLOWS:

1. The Applicant shall, in connection with the existing sewage treatment plant and until such time as a new sewage treatment facility is constructed, ensure that:

   (a) the said plant is maintained and operated to the satisfaction of the Environmental Management Division of the said Department and in such a manner as to:

      (i) minimize the release of offensive odours at the site and along the route of Gopher Creek;

      (ii) control any nuisance condition at the site or along the route of Gopher Creek; and

      (iii) provide for the removal of sludge at least every two months and the innocuous disposal of the removed sludge;

. . . . 3

Cont'd . . .

1. (b) the effluent, as discharged, is subjected to continuous chlorination sufficient to provide at any time a residual of not less than 0.5 milligrams per litre of chlorine after 15 minutes contact.

2. The Applicant shall, on or before the 31st day of October, 1976, file with the Environmental Management Division construction drawings, specifications and applicable engineering reports on the proposed new sewage treatment facility.

3. The Applicant shall so design, construct and operate the proposed sewage treatment facility that:

   (a) the average 5-day biochemical oxygen demand of the effluent is not in excess of 30 milligrams per litre;

   (b) the non-filtrable residue of the effluent is not in excess of 30 milligrams per litre;

   (c) the total coliform content of the effluent as indicated by the MPN Index, is not in excess of 1500 per 100 millilitres of sample;

   (d) domestic sewage only is discharged to the facility unless adequate provision is made for the treatment of industrial wastes;

   (e) there is no contamination of groundwater;

   (f) the occurrence of offensive odours is minimized;

   (g) any waste sludge produced is disposed of in a manner satisfactory to the said Division;

   (h) the route of discharge is by enclosed pipe leading to the Assiniboine River.

4. The Applicant shall ensure that the proposed sewage treatment plant is in operation on or before the 31st day of December, 1977.

Order No. 458 as varied by The Clean Environment Commission
Becomes Order No. 458VC

Order No. 458VC

Dated at the City of Winnipeg

this 9th day of APRIL, 1976.

G E Moore

Chairman,
The Clean Environment Commission.

AN ORDER OF THE CLEAN ENVIRONMENT COMMISSION

UNDER THE CLEAN ENVIRONMENT ACT

RE: THE CLEAN ENVIRONMENT COMMISSION and THE TOWN OF VIRDEN, Applicant,

WHEREAS pursuant to the provisions of the Clean Environment Act, Reid, Crowther and Partners Limited filed a proposal with the Department of Mines, Resources and Environmental Management on behalf of the Town of Virden, in connection with the operation of a sewage treatment plant with continuous discharge via an enclosed pipe to the Assiniboine River, said plant being located at Lots 12 and 13, Block 170, Plan 197 BLTO in the Town of Virden, Manitoba;

AND WHEREAS in the absence of limits being prescribed by a Regulation under the said Act, the proposal was referred to The Clean Environment Commission for the prescribing of limits;

AND WHEREAS no representation was made by any person who is or who is likely to be affected by an Order of the Commission prescribing limits in connection with the said operation;

AND WHEREAS the Commission, on its own accord, held a public hearing on the 17th day of October, 1977 in the Town of Virden to receive representations and evidence concerning the newly developed technology represented by the proposed deep shaft sewage treatment plant;

AND WHEREAS the Commission considered the application on the 26th day of September and the 14th day of November, 1977;

IT IS HEREBY ORDERED THAT

1. The Applicant shall ensure that the said sewage treatment plant is constructed, maintained and operated in such a manner that, on and after the 31st day of December, 1978:

   (a) the release of offensive odours is minimized;

   (b) the contamination of groundwater is prevented;

   (c) the five-day biochemical oxygen demand of the effluent from the sewage treatment plant is not in excess of 30 milligrams per litre;

   (d) the nonfiltrable residue of the effluent from the sewage treatment plant is not in excess of 30 milligrams per litre;

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Cont'd . . .

1. (e) the fecal coliform content of the effluent from the sewage treatment plant, as indicated by the MPN Index, is not in excess of 200 per 100 millilitres of sample;

   (f) any waste sludge produced by the sewage treatment plant is disposed of in a manner satisfactory to the Environmental Management Division of the Department of Mines, Resources and Environmental Management;

   (g) effluent from the sewage treatment plant is discharged via an enclosed pipe to the Assiniboine River.

2. The Applicant shall provide the necessary facilities and shall arrange for the taking and analysis of samples of the influent sewage and the effluent sewage of the said sewage treatment plant and the submission of analytical results, in a manner approved by the said Division.

3. The Applicant shall arrange for the continuous measurement of the rate of flow of the effluent sewage from the said sewage treatment plant through the procurement and installation of any equipment or facilities necessary for that purpose and shall thereafter ensure that said measured sewage flows are recorded on a daily basis and submitted to the said Division upon request. Said flow measurement equipment shall be so designed, installed, calibrated and operated that the daily flow measurement is accurate to within five percent of the actual value of flow.

4. Order No. 458VC shall be, and the same is hereby rescinded.

Order No. 760

Dated at the City of Winnipeg

this 5th day of December, 1977.

F. G. Moore

Chairman,
The Clean Environment Commission.